

**National Aeronautics and Space Administration**

**Small Business Technology Transfer (STTR) Program**

**Proposals Selected for Negotiation of STTR Phase I Contracts**

**Sorted by Company and Proposal Number**

**July, 1994**

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**AEROMOVER SYSTEMS CORP**

2500 BISHOP CIRCLE  
DEXTER, MI 48130  
RONALD A. MEYER 313-426-2376

**THE UNIVERSITY OF MICHIGAN**

3003 SOUTH STATE ST  
ANN ARBOR, MI 48109  
94-03-940085 LaRC  
DIFFERENTIATED UNIVERSAL END EFFECTOR

**AIRBORNE RESEARCH ASSOCIATES**

46 KENDAL COMMON RD  
WESTON, MA 02193  
RALPH J. MARKSON 617-899-1834

**MASSACHUSETTS INSTITUTE OF TECHNOLOGY**

244 WOOD ST  
LEXINGTON, MA 02173  
94-01-940092 LaRC  
LASI: LIGHTNING AND STORM INTENSITY/WEATHER WARNING SYSTEM

**AMHERST SYSTEMS INC**

30 WILSON RD  
BUFFALO, NY 14221  
DONALD A. HESS 716-631-0610

**STATE UNIVERSITY OF NEW YORK AT BUFFALO**

3435 MAIN ST  
BUFFALO, NY 14214  
94-03-940104 LaRC  
FOVEAL SENSOR AND IMAGE PROCESSOR PROTOTYPE

**ARNAV SYSTEMS INC**

16923 MERIDIAN EAST  
PUYALLUP, WA 98373  
FRANK WILLIAMS 206-848-6060

**RESEARCH TRIANGLE INSTITUTE**

525 BUTLER FARM RD SUITE 108  
HAMPTON, VA 23666-1564  
94-01-940024 LaRC  
AN AFFORDABLE GENERAL AVIATION INTEGRATED COCKPIT DISPLAY  
SYSTEM

-more-

**CIRRUS DESIGN CORP**

4515 TAYLOR CIRCLE  
DULUTH, MN 55811  
DEAN VOGEL 218-727-2737

**RESEARCH TRIANGLE INSTITUTE**

3040 CORNWALLIS RD  
RESEARCH TRIANGLE PARK, NC 27709  
94-01-940152 LaRC  
LOW COST AIRCRAFT ENGINE AND FLIGHT DATA RECORDING SYSTEM

**CYBERNET SYSTEMS CORP**

1919 GREEN RD, SUITE B-101  
ANN ARBOR, MI 48105  
HEIDI N. JACOBUS 313-668-2567

**THE UNIVERSITY OF MICHIGAN COLLEGE OF ENGINEERING**

OFFICE OF TECHNOLOGY TRANSFER 2901 HUBBARD  
ANN ARBOR, MI 48109-2106  
94-01-940060 LaRC  
A LOW-COST HIGH-PERFORMANCE VISUAL-AUDITORY-TACTILE VIRTUAL  
REALITY TRAINER

**ENDORBOTICS CORP**

5 DEERWOOD TRAIL P.O. BOX 4408  
WARREN, NJ 07059  
DANIEL AHN 908-271-9088

**UNIVERSITY OF CALIFORNIA BERKELEY REGENTS UNIVERSITY**

336 SPROUL HALL, UNIVERSITY OF CALIFORNIA BERKELEY  
BERKELEY, CA 94720  
94-03-940029 LaRC  
MILLI-ROBOTS FOR SURGICAL TELEOPERATION

**INTEGRINAUTICS CORP**

P.O. BOX 9475  
STANFORD, CA 94309  
CLARK E. COHEN 415-725-4124

**STANFORD UNIVERSITY**

DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS  
STANFORD, CA 94305-4085  
94-01-940048 LaRC  
HIGH INTEGRITY PRECISION LANDING FOR GENERAL AVIATION USING THE  
GLOBAL POSITIONING SYSTEM

**KNOWLEDGE BASED SYSTEMS INC**

1408 UNIVERSITY DR EAST  
COLLEGE STATION, TX 77840-2335  
PAULA S. DEWITTE 409-260-5274

**TEXAS ENGINEERING EXPERIMENT STATION**

TEXAS A&M UNIVERSITY  
COLLEGE STATION, TX 77843  
94-01-940055 LaRC  
GENERAL AVIATION PILOT ADVISORY AND TRAINING SYSTEM (GAPATS)

**MID-SOUTH ENGINEERING INC**

P.O. BOX 128015  
NASHVILLE, TN 37212  
ROBERT JOEL BARNETT 515-383-8877

**TENNESSEE STATE UNIVERSITY**

3500 JOHN A. MERRITT BLVD  
NASHVILLE, TN 37209  
94-03-940020 LaRC  
SPHERICAL MOTOR AND NEURAL CONTROLLER FOR MICRO-PRECISON  
ROBOT WRIST

**QUALITY INFORMATION SYSTEMS INC**

10680 WEST PICO BLVD SUITE 260  
LOS ANGELES, CA 90064  
JOEL FLEISS 310-287-0728

**UNIVERSITY CALIFORNIA AT LOS ANGELES**

4732 BOELTER HALL  
LOS ANGELES, CA 90024-1596  
94-02-940011 GSFC  
ELECTRONIC INTERACTIVE DOCUMENT CHANGE REQUESTS

**ROBOTICS RESEARCH CORP**

P.O. BOX 206  
AMELIA, OH 45102  
JAMES P. KARLEN 513-831-9570

**JET PROPULSION LABORATORY**

4800 OAK GROVE DR  
PASADENA, CA 91109  
94-03-940120 LaRC  
NEXT GENERATION CONTROLLER FOR REDUNDANT ROBOTS

**SEAGULL TECHNOLOGY INC**

1310 HOLLENBECK AVE  
SUNNYVALE, CA 94087  
JOHN A. SORENSEN 408-732-9620

**STANFORD UNIVERSITY**

AERONAUTICS & ASTRONAUTICS DEPARTMENT  
STANFORD, CA 94305  
94-01-940108 LaRC  
GPS-BASED ATTITUDE AND VELOCITY ESTIMATION SYSTEM

**TRANSITIONS RESEARCH CORP**

SHELTER ROCK LN  
DANBURY, CT 06810-8159  
JOHN M. EVANS JR. 203-798-8988

**UNIVERSITY OF SOUTHERN CALIFORNIA**

COMPUTER SCIENCE DEPARTMENT MAIL CODE 0781  
LOS ANGELES, CA 90089-0781  
94-03-940151 LaRC  
COMBINED DISTANCE AND ORIENTATION SENSOR (CODOS)

**VISUAL INSPECTION TECHNOLOGIES INC**

27-2 IRONIA RD  
FLANDERS, NJ 07836-9124  
WILLIAM R. SIGRIST 201-927-0033

**SRI INTERNATIONAL**

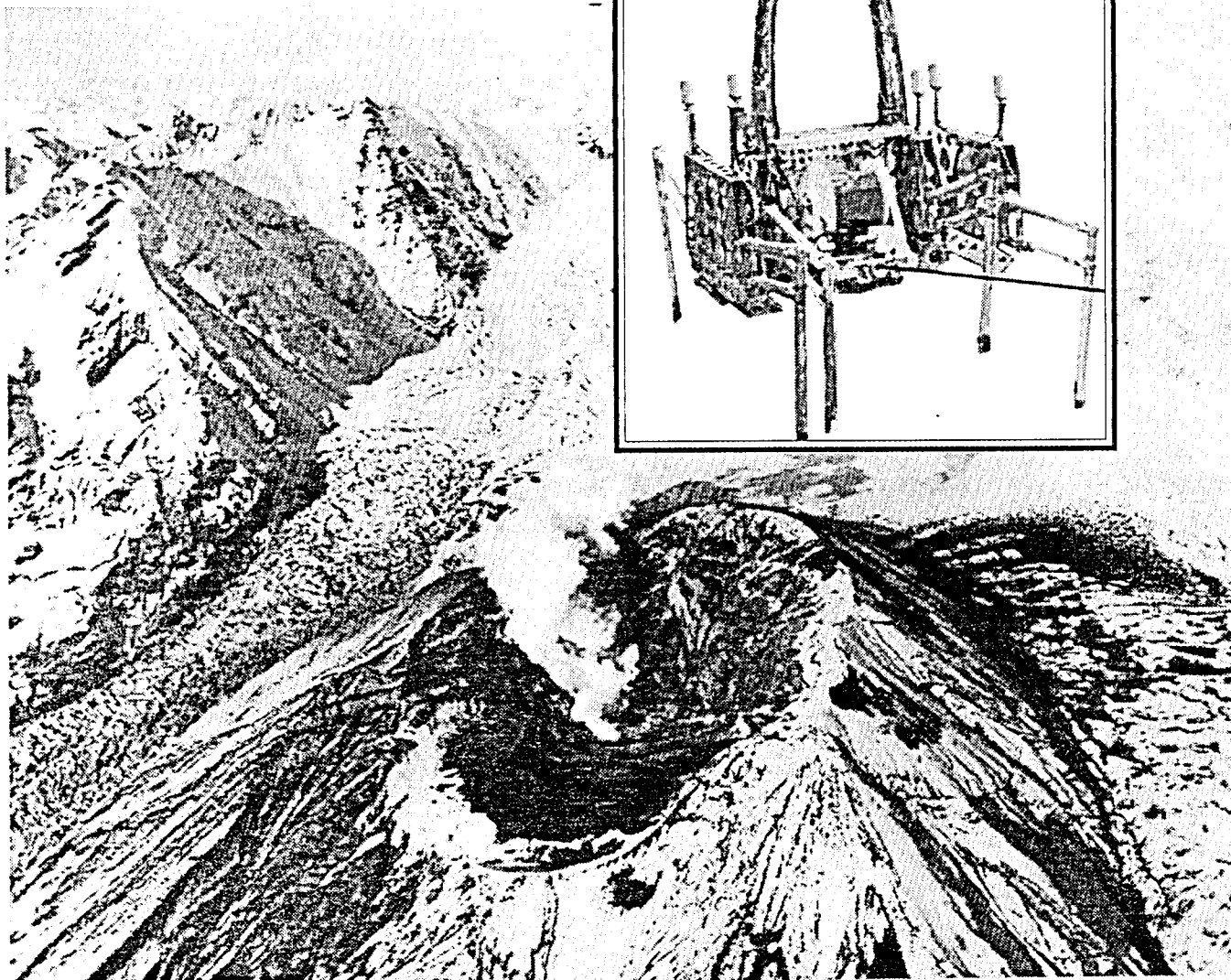
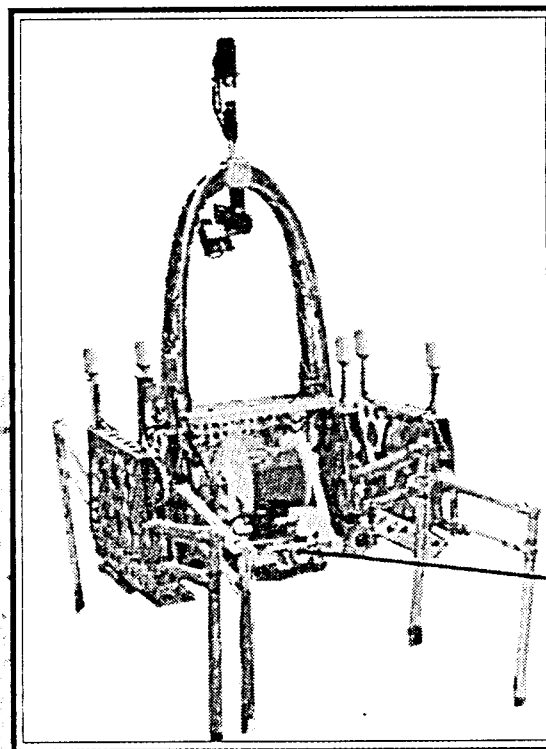
333 RAVENSWOOD AVE  
MENLO PARK, CA 94025  
94-03-940097 LaRC  
MOBILE MAGNETIC ROBOTS FOR INSPECTION OF STEEL STRUCTURES

JULY 6  
94 - DANTE



# Dante II at Mt. Spurr

July 1994  
Press Kit



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#### **General Release**

RELEASE: 94-Dante

July 6, 1994

#### **NASA-UNIVERSITY TEAM SET TO EXPLORE VOLCANO WITH ROBOT**

During the third week of July, an eight-legged, tethered robot will descend into the active crater of Mt. Spurr, an Alaskan volcano 80 miles west of Anchorage. The robot, Dante II, will be controlled, via satellite and Internet connections, by a team with representatives from NASA, Carnegie Mellon University, the Alaska Volcano Observatory, and other government, university and private organizations.

The robot, Dante II, is a direct descendant of the Dante robot which tried over the 1992-93 New Year's holiday to descend into the live Antarctic volcano Mt. Erebus. That mission ended with the robot only 28 feet into the crater when the fiber optic cable, which was its communications lifeline, kinked and was broken due to physical and temperature stress conditions.

The Dante II robot will be deployed into the active, steeply-sloping vent of the young satellitic crater on the south slope of the historic volcano Mt. Spurr this July 18 to begin a scheduled five-day scientific-sample taking exploration of the crater floor.

#### **Minimum cost a major factor in project**

NASA has provided \$1.7 million to Carnegie Mellon University's Robotics Institute, Field Robotics Center to redesign, test and advance the basic mechanical, electronic and computer technologies of the Dante robot mechanism in order to carry out this project. The Dante I project in Antarctica was executed, from start to conclusion, for about \$2 million. The Dante II project has relied on NASA funding and in-kind services or loaned hardware in order to proceed.

The agency goals for this project are aimed directly at contributions to space exploration which can be made from advances in human telepresence, robot exploration, and communications and computer technologies. The Carnegie Mellon University has interests which include extending the results of this demonstration to more practical applications elsewhere on Earth including additional volcanic exploration, mining and mine safety operations, large-scale agricultural deployment (remotely-controlled reaping of huge fields for example), and hazardous environment operations for industrial and municipal organizations.

Carnegie Mellon University, NASA and several industrial firms recently inaugurated the Robotics Consortium in Pittsburgh to further these practical and potentially profitable commercial goals.

The Alaska Volcano Observatory (AVO), operated jointly by the U.S. Geological Survey, the Alaska State Division of Geological and Geophysical Surveys, and the University of Alaska-Fairbanks Geophysical Institute, has a goal of obtaining in situ data on the chemical and temperature properties of the crater floor, and a higher resolution geomorphological map of the crater interior.

The University of Alaska-Anchorage is providing housing support for all the Dante team members and additionally is providing significant logistics and student work-study and volunteer support for the public information elements of this project.

Contributions to the project from Eastman Kodak Company, GCI Communications, Inc., W.L. Gore Inc., VTEL Inc., Chugach Electric Power, Inc., StereoGraphics Inc., and others are aimed at showing the usefulness and applicability of those firms' products and services to scientific and technical projects such as this with additional goals of potentially increasing the end-user market for these firms' products or services.

### **Telerobotics will improve human-robot interactions**

NASA's Telerobotics Program encompasses research and development activities at many NASA centers and a large number of associated firms and universities. Carnegie Mellon University's Field Robotics Center (part of the university's Robotics Institute) has developed expertise in ambulatory robots -- robots which walk. Other kinds of locomotion which are being pursued by NASA and its allies include robots which use wheels, robots which are suspended between opposing tethers such as "spider" robots, robots with single and multiple dexterous limbs (the most common kind used in industrial capacities and which includes welding robots), and free-flying robots with sensors or dexterous limbs (envisioned as potential orbital retrieval and maintenance devices such as the University of Maryland's Ranger project).

The objectives which were pursued in the Antarctic two years ago included validating several robot technologies in harsh and unforgiving environments, and to ultimately transfer these technologies to future planetary missions. This

technology validation including evaluating the utility of legged vehicles in harsh terrains and demonstrating the ability of communications links and computer software programs to enable a human located remotely from the robot to both "sense" the environment (the telepresence element) and to effectively direct the actions of the remote robot (computer assisted and enhanced remote control elements).

Both of these objectives remain NASA goals for the Dante II mission in Alaska. The cold and dry climate of the Earth's Antarctic region is close enough that some simulations representing the environmental conditions which would be found on Mars can be simulated and mechanical operation in these conditions can be assessed and advanced.

### **Volcanoes remain hazardous duty to human geologists**

Both NASA and AVO are interested in proving the concept of remote, robotic, volcano explorations since many of the volcanoes of interest are also extremely hazardous to human exploration. Eight volcanologists have died in recent accidents while attempting to descend into volcanoes located as distant as Japan and Ecuador.

The crater inside Mt. Spurr is considered too dangerous for human exploration but is of interest to the AVO science team and to the Volcano Hazards Program of the USGS.

Mt. Spurr was a dormant volcano for 39 years until 1992. Since 1992 Mt. Spurr has erupted three times from a crater off the south flank of the mountain's main cone. The crater is located at 7,575 feet elevation and includes a sheer drop of nearly 1,000 feet from one wall. The other side of the crater consists of a rock-strewn slope descending down at angles from 20 to 45 degrees.

NASA's Ames Research Center Intelligent Mechanisms Group is working directly with the Carnegie Mellon University robot team to apply and improve the Ames group's Virtual Environment Visualization Interface software. This software has undergone continuous improvement since the Ames team began its work in this area in 1991. These computer enhancements have important implications for terrestrial science and exploration applications and are considered by NASA to be critical to the success of robotic planetary surface missions. This software will allow Dante II robot controllers in Anchorage to see what the robot sees and to have robot "sense of self" information layered on top of the scene in such a way that the operator can then move around in the virtual environment.

The operations for this project will involve a large number of logistics moves, communications links which have to be established and tested, and field equipment in addition to the Dante robot which have to be placed on the side of the volcano. The team will move the associated equipment and disassembled robot to Alaska during the first week of July. The U.S. Air Force Reserve 911th Air Lift Group will be providing transport using a C-130 cargo plane on a long-distance training exercise. The C-130 will land at Elmendorf Air Force Base,

north of downtown Anchorage. The equipment will be reassembled, robot included, and tested near the air base prior to any subsequent deployment.

About the second week of July, the robot, a field electric generator, and a portable ground terminal for satellite communications will be transported the approximately 55 miles across Cook Inlet to an airstrip operated by Chugach Electric for their Beluga Power Plant near Mt. Spurr, west-northwest of Anchorage and directly across the inlet. Several helicopter trips from the airstrip to the rim area of the Mt. Spurr crater are envisioned as necessary to get all the gear and supporting personnel to the mountain. Because of the safety hazards associated with the volcano, no personnel will be left on the mountain during periods when a helicopter is not there for immediate evacuation.

The Alaska Volcano Observatory employs satellite and aircraft observations and maintains a large network of sensors around Mt. Spurr and other Alaska Aleutian Chain volcanoes. The Mt. Spurr team will be in radio contact with operations geologists at the Anchorage offices of the AVO for seismic and other volcano indications. In the event of any activity suggesting impending volcano eruptions, the Dante team will be immediately removed via helicopter for safety reasons. This level of risk mitigation will continue during any human operations at the Mt. Spurr site.

#### **Remote control center to be established in Anchorage**

Concurrent with the Mt. Spurr activities, other members of the Dante team will be setting up and testing the robot remote control computer equipment at a location near the communications facilities of GCI in midtown Anchorage. From that location, satellite signals coming from Dante will be received and forwarded through terrestrial fiber cables to the Ames Research Center where the video will be analyzed and three dimensional information extracted and used in the VEV software routines. Internet connections from the GCI site will also be established to Ames and these connections will be used to provide the feedback information from Ames to the robot control center. Computers at the GCI site will merge the information and be used by the Carnegie Mellon University team to program and control Dante.

Additional communications facilities will be set up for a separate feed of the robot video signal to Washington, D.C. using the NASA's experimental, revolutionary Advanced Communications Technology Satellite. A very small powerful earth station called a "T-1, VSAT" will transmit the Dante video via ACTS, in geosynchronous orbit 23,300 miles above equator, to a similar terminal at the National Air and Space Museum on the Mall in downtown Washington. This link is to demonstrate the instant "drop in" utility of small powerful satellite earth stations at both remote and urban locations. Industry partners working with the ACTS system are testing remote medical, business, science, military, and disaster relief uses of these new satellite technologies.

These experiments are confirming that satellites remain a major building block in the global information super-highway.

The support activities provided by the ACTS satellite are scheduled to coincide with activities taking place at the Museum in honor of the 25th anniversary of the landing of the Apollo 11 crew on the Moon on July 20, 1969 and to demonstrate the degree to which communications have advanced in the intervening two-and-a-half decades.

Once the Dante equipment has been set up and tested at the Mt. Spurr crater site and the GCI-based control room facilities have been installed and checked out, the team plans to carry out an end-to-end communications test from the robot through the satellite links to Anchorage on to Ames and back to Anchorage. Pending the success of these tests, the deployment of Dante II down the steep and rock and ice strewn interior crater of Mt. Spurr is anticipated to begin on July 18.

#### **Robot's descent into volcano expected to last several days**

The descent down the nearly 500 feet of slope to the crater floor is expected to take two days. The team expects to be "working" the robot from 10:00 am to 10:00 pm Alaska time. Once it arrives on the floor, Dante is to explore the crater floor area using its cameras and geochemical sensors. This exploration is expected to take two days. Following this phase, which will include several different levels of autonomous robot control up to and including full control vested in the robot's onboard high-power computing system, the Dante II robot will begin its ascent up to the crater rim.

The trip back up the interior wall is expected to take another two days. The team has scheduled several days of contingency time into this schedule to accommodate such anticipated problems as weather-induced delays. Dante is a tether robot so it will be in constant communication with the satellite terminal and will receive all of its electric power from the generator stationed adjacent to the satellite unit. Under nominal conditions, Dante II should step out of the crater on July 22 or 23. The team would then reverse their logistics operations and remove the equipment via helicopter and fixed-wing aircraft back to Elmendorf Air Force Base for packing and a return boat and truck to Pittsburgh.

Associated with the NASA planetary exploration goals, the robot will be remotely controlled from the Ames Intelligent Mechanisms Group control room during portions of the crater floor activity. As a demonstration of telepresence and remote control operations using satellite-based Internet communications links, the mast-mounted camera on Dante II will also be controlled via a control station set up at the National Air and Space Museum in Washington. Exact dates and times for these two remote control operations are dependent on conditions in both Anchorage and at the robot's location inside Mt. Spurr but will be announced as much in advance as can be allowed.

The entire operation carries a high degree of risk and consequently could be halted during any of the various stages because of equipment, communications or computer/software-related problems or because of inclement weather or seismic activity at Mt. Spurr. NASA, Carnegie Mellon University, the AVO and the associated other organizations and companies are fully aware of this risk

and the equal risk that one of these contingencies may result in the loss of the robot or the Mt. Spurr-rim-based equipment.

### **Dante team used Antarctic experience to guide redesign efforts**

NASA and Carnegie Mellon University Field Robotics Center staff have taken extraordinary measures based on their experience in the Antarctic and on advice provided by both the AVO staff and their colleagues at the Cascades Volcano Observatory in Washington state and Hawaii Volcano Observatory, on Hawaii.

The robot motion mechanism has been redesigned and strengthened in areas which were found to be susceptible to either break or weakness. Each of the eight legs is driven by a servo-motor system which raises or lowers the leg individually. The legs are paired in mates of four and four. These mates are called "frames" and moving the frames, relative to each other, is how the robot achieves forward or backward locomotion. Each leg has stress gages and contact sensors. Each servo-motor has a precision motion sensor to indicate the absolute position of the servo. Each servo is driven by an independent control amplifier.

The robot is also equipped with eight cameras, any two of which can be selected for transmission from the robot to the satellite terminal. Four cameras can also be selected for use as a quad-split image providing the control room team with what would be a left-front, right-front, left-back, and right-back view. The cameras are situated at the robot left and right sides in the front and rear. Two other cameras are set up as a stereo pair and are located on a mast mounted amid the robot's main structural frame between the computer "brains" box and the tether-wind mechanism box.

The stereo cameras will provide the control room staff and the Ames IMG team with a real 3-dimensional look from the robot's point of view. This system has been successfully deployed for several years now both on surface robots and on underwater robots which the Ames group has used beneath the ice at McMurdo Sound in the Antarctic. The mast camera is controllable in up-down and left-right axes. Additionally, Kodak has provided a high-resolution still-frame camera which was undergoing late integration onto the robot. If the camera is successfully integrated and software patches necessary for its operation are incorporated into the robot operating system, the camera will be used to take single snapshots of interior views. These images will be stored in the camera's onboard computer system until completion of each day's activities.

The experience with Dante I on Mt. Erebus, Antarctica, suggested that a more reliable and rugged tether reel-wind mechanism was required. Carnegie Mellon University has obtained such a unit and tested it under severe stress conditions at least three times in excess of any expected contingency situation for the Dante II project at Mt. Spurr.

### **New tether system tested under extreme conditions**

Likewise, the tether and communications cables used in the Antarctica came under scrutiny at a post-mission review after the Dante I cables underwent

temperature and mechanical-related stress at the Mt. Erebus expedition. The new tether cable system was built by W. L. Gore and consists of a 1,000 volt AC power line pair with ground wire embedded with five twisted-pair cables all bound to a weight and strength-bearing primary tether cord and encapsulated with shielding and two outer strength and abrasion layers. One of the twisted pair will serve as the Ethernet line, the other four twisted pair cables are for serial communications access to the four computer processors. This cable has been tested in cold-chambers at Carnegie Mellon University at temperatures in excess of those expected under worst-case conditions at Mt. Spurr and with "snap and drop" tests using acute-angle pulleys and weights in excess of that presented by the Dante II robot.

There remain several single-point mechanical or procedural failure modes which could halt the project. The power is generated by a single rim-based generator. The power goes through a single robot-mounted power transformer. Likewise, the satellite station on the rim is a single unit. A failure of the servo-motor, actuator or brake, or amplifier system associated with the frame advance mechanism would be a mission-halting failure. Individual leg servos, amplifiers or brakes can fail producing an impaired ability, but not a mission failure.

As Ames and their Intelligent Mechanisms Group have advanced the state of virtual reality software and computer-enhanced telepresence remote control capabilities, Carnegie Mellon University's Robotics Institute team has advanced the state of autonomous robot control. The Robotics Institute has continued development of what they call "task control architecture" for robot functions.

At the lowest level, equivalent to a nerve activating a single muscle fiber in an animal, the robot control team can activate and control single servo-motors and, through them, single leg up-down actions. This can be done for the eight leg systems, the frame advance system and the frame turning system. It can also be done for any associated additional action such as tether reel-out, tensioning, or reel-in, for camera control, etc.

#### **Robot degrees of autonomy range from none to nearly self-guided**

The next level of control endows the robot with management over its individual leg actions and the various pressure and stress sensors which tell its onboard computer whether the leg is obstructed or not and whether it has moved as far as intended, either up or down. This level of control allows the human to use collected sets of legs under robot control to manually control such aspects as the overall robot elevation above the ground, the robot's inclination and attitude with respect to both the ground and with respect to an absolute plumb condition.

The next level vests robot control over such aspects as overall robot attitude and symmetry and allows the human to command actions such as coordinated forward, turning or backward motion. The level above that gives the onboard system even more autonomy and allows the human to indicate general distance and direction, letting the robot's control system achieve them under local control.

END OF GENERAL RELEASE

## **Timeline of activities**

### **July 5**

Robot, Mt. Spurr support equipment and control station gear packed aboard US Air Force (Reserve) C-130 cargo plane;

### **July 6**

Robot and equipment leave for Alaska (refueling/stopover in North Dakota); project team members and support team leave for Anchorage on commercial air carriers;

### **July 7**

C-130 arrives Elmendorf AFB, Anchorage; team off loads and inspects, begins separating equipment for various deployments;

### **July 9-11**

Dante is assembled along with support gear and taken to test site in nearby hills for practice runs; separate members of team begin assembling and testing control station (3600 block of C St., Frontier Bldg.) and connections through satellite and internet;

### **July 11-12**

Dante is tested at nearby location using satellite links and the rest of the actual hardware configured as it would be on Mt. Spurr;

### **July 15-17**

Robot and support gear are moved in stages to air strip at Beluga (Chugach Power landing strip) via fixed-wing aircraft; equipment is set up in staging areas for deployment to Mt. Spurr (deployment staging areas are for equipment at the fuel site, the generator site, the earth station satellite site, the tether anchor site, and the rim Dante deploy site); once all gear is at Beluga site, helicopter will lift equipment and place in previously-scouted locations on Mt. Spurr rim and set up and hooked up;

### **July 18**

Dante and control station (including Ames links) will be end-to-end tested for communications and command/control; upon confirmation that all components are operationally ready, team will begin descent of Dante into active crater;

### **July 18-22**

Dante's descent and traverse will be performed in stages with the robot descending to the lower level plain inside the crater in the first two days; science observations (though continuous throughout) will be the principal objective once the robot is on crater floor; traverse across floor and back will take one to two days; once the floor area has been examined, Dante will begin its ascent up the inner crater wall; Dante is expected to emerge at the rim area on/about July 22 (this schedule is based on optimal weather

conditions and on no contingencies associated with the robot, the rim-mounted equipment or the communications links. Several days of contingency time have been built into this schedule which allow for up to three days of rim equipment fixes or communications links fixes.

### **July 22-25**

Team reverses the deployment activities and moves the equipment, in stages, from the rim to Beluga and then on to the hangar area at Elmendorf AFB; concurrent with this activity the control area crew is disinstalling and packing the computer support equipment for shipment back to the Lower 48. The robot and equipment will be shipped from Anchorage to Seattle and then trucked to Pittsburgh.

### **Participants (names, organizations, contributions)**

#### Dante II Program Management/Project Team

David Lavery, NASA Headquarters, Washington, Office of Advanced Concepts and Technology, Telerobotics Program Manager  
John Bares, Carnegie Mellon University, Robotics Institute, Field Robotics Center, Pittsburgh, Dante II Project Manager  
William "Red" Whittaker, Carnegie Mellon University, Robotics Institute, Field Robotics Center, Pittsburgh, Dante II Principal Investigator;  
Scott Boehmke, Carnegie Mellon University, Robotics Institute, Field Robotics Center, Pittsburgh, Dante II communications engineer;  
Chris Fedor, Carnegie Mellon University, Robotics Institute, Field Robotics Center, Pittsburgh, Dante II software engineer;  
Dave Wettergreen, Carnegie Mellon University, Robotics Institute, Field Robotics Center, Pittsburgh, Dante II software architect/engineer;  
Dimitrios Apostolopolos, Carnegie Mellon University, Robotics Institute, Field Robotics Center, Pittsburgh, Dante II mechanical engineer;  
Tim Hegadorn, Carnegie Mellon University, Robotics Institute, Field Robotics Center, Pittsburgh, Dante II logistics and field engineer;  
Deepak Bapma, Carnegie Mellon University, Robotics Institute, Field Robotics Center, Pittsburgh, Dante II mechanical and motion control engineer;  
Butler Hine, Ames Research Center, Intelligent Mechanisms Group, Mountain View, Calif., telepresence scientist/communications architect;  
Terry Fong, Ames Research Center, Intelligent Mechanisms Group, Mountain View, Calif., telepresence scientist/communications architect;

#### Science and Support Activities Team Members

Terry Keith, Alaska Volcano Observatory, USGS, Anchorage, Scientist-in-Charge, volcanologist, hazard analysis and science advisor;  
Terry Gerlach, Cascades Volcano Observatory, USGS, Vancouver, WA, volcanologist, volcanic gas expert and science advisor;  
Chris Nye, Alaska Volcano Observatory, Alaska Division of Geological and

Geophysical Surveys, volcanologist, Mt. Spurr expert, and hazard analysis and science advisor;  
Steve McNutt, Alaska Volcano Observatory, University of Alaska Fairbanks Geophysical Institute, volcano seismologist and hazard advisor;  
Jeff Sutton, Hawaiian Volcano Observatory, USGS, Hawaii, volcanic gas geochemist and science advisor;  
John Beniot, Alaska Volcano Observatory, University of Alaska Fairbanks Geophysical Institute, volcano seismologist and hazard analysis;  
Game McGimsey, Alaska Volcano Observatory, USGS, Anchorage, volcanologist;  
Tina Neal, Alaska Volcano Observatory, USGS, Anchorage, volcanologist;  
Tom Miller, Alaska Volcano Observatory, USGS, Anchorage, volcanologist;  
Mike Doukas, Alaska Volcano Observatory, USGS, Anchorage, volcanologist;  
Bill Ingalls, CCI Inc., photographic documentation for NASA Headquarters;  
Chris Allingham, CCI Inc., video documentation and mission video support for NASA Headquarters;  
Lewis Research Center, ACTS satellite and VSAT terminals and communications support;

#### Equipment, Logistics and Expertise Support

The following organizations and companies have provided significant equipment, service or logistics support for this technology demonstration:

Alaska Volcano Observatory, volcanology expertise and hazard analysis;  
Cascades Volcano Observatory, volcanology expertise and science advice;  
Hawaii Volcano Observatory, volcanology expertise and science advice;  
W. L. Gore, Inc., tether cable and environmental support clothing;  
Eastman Kodak Co., digital still 35mm camera and control software;  
VTEL, Inc., digital video compression hardware;  
GCI Network Systems, Inc., data and video satellite and terrestrial services;  
NASA Science Internet, data service;  
NASA Program Support Communications Network, program and data service;  
Chugach Electric Power Inc., portable electric generator equipment;  
StereoGraphics Inc., stereo video imaging hardware;  
Silicon Graphics Inc., graphics workstations;  
University of Alaska-Anchorage, housing, logistics and public affairs support;  
US Air Force Reserve, 911th Air Lift Group, logistics and transportation service;  
US Marine 2nd Landing Support Battalion, BTO Company, 2nd Air Delivery Platoon, airlift pallet construction and advice (this was an entirely volunteer effort from military personnel based at Camp Lejeune, NC);  
US Marine 4th Combat Engineer Battalion, Company A, technical advice on anchoring the tether at the top of the Mt. Spurr rim;  
Alaska Helicopter Service, helicopter support;

## **Description and performance specifications of Dante II**

The Dante II robot is an eight-legged, frame walking robot capable of rappelling on any incline from level (zero degrees inclination) to vertical (90 degrees of inclination). It has four distinct control modes which range from supervisory control of its limbs to full, autonomous, teleoperation. It can traverse any plane at an average rate of one centimeter per second (60 cm/min, or two feet a minute).

Including its sensor mast, which looks like a miniature replica of the Arch at St. Louis, the robot is 10 feet tall. It is 10 feet from front-to-back and just over eight feet wide. The full robot system weighs 1,700 pounds.

The tether system consists of an automatic tensioning reel mechanism and 1,000 feet of .45 inch-diameter multiple wire, multiple layer cable provided by W. L. Gore.

Each of the eight limbs is controlled by a control-amplifier powered precision servomotor which moves the double-cantilevered limbs up and down. Each of the limbs consists of tubular aluminum sections with pivot joints strengthened at the stress points by specially machined sections. The main cross-member of each limb is also strengthened by a longitudinal stress longeron welded to the limb section.

Two of the limbs on each side are connected to an inner frame assembly, the other two are connected to an outer frame assembly. By moving inner frame limbs up, advancing the inner frame with respect to the outer frame and then lowering the inner frame limbs and lifting the outer frame limbs, the robot achieves linear motion. This process is repeated countless times for each dozens of feet advanced. Each frame can be pivoted with respect to the other by as much as 11 degrees. When the inner frame advances (or retreats) the reel mechanism is automatically releasing (or retrieving) tether cable which is maintained at a constant tension.

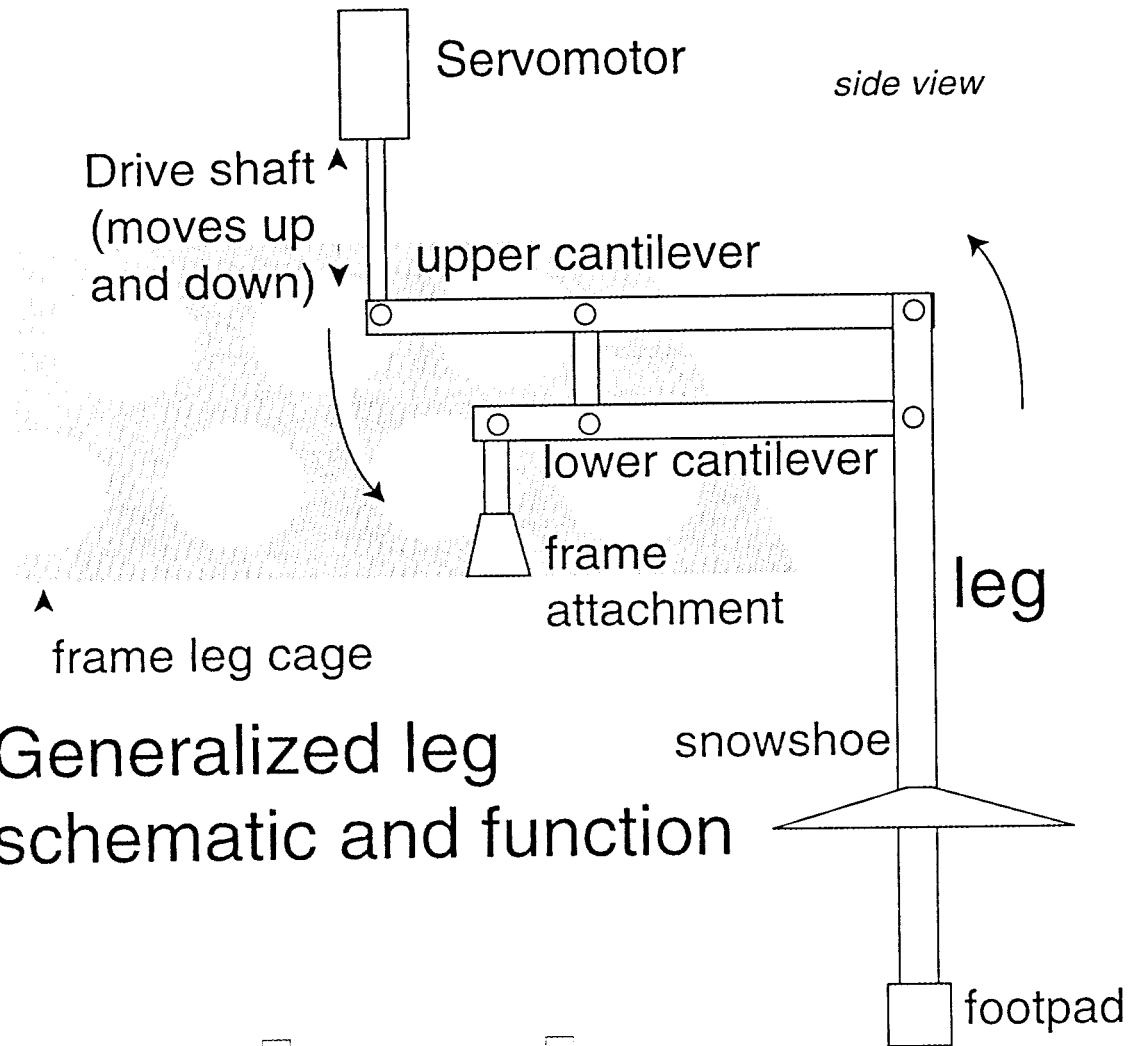
Using this method of locomotion has several advantages including the fact that at any given moment, four robot limbs, at the four corners of the overall robot frame, are in contact with the ground. Because each limb is independently controlled, the robot can be in a stable, horizontal and plumb position even though the ground may be completely uneven and unlevelled.

The maximum object height the robot can clear is 50 inches vertical. The maximum open space the robot can span in any direction is 35 inches. Because it is limited by the tether length, the maximum rappelling range of the robot is 1,000 feet.

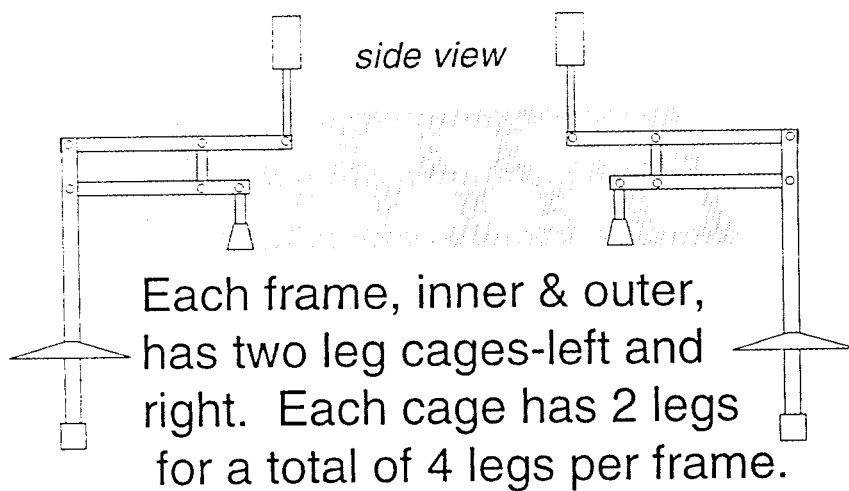
### **Robot has sensors located throughout**

The robot uses sensors located throughout its frame and limbs as well as imaging information provided by a laser ranging instrument and stereo cameras to provide guidance and navigation information to its onboard processing system. There are three force sensors on each leg and a precision turn indicator for each of the servomotors which drive the legs. Each of the actuators on the frame, both for advancing and retreating and for turning have absolute-position sensors.

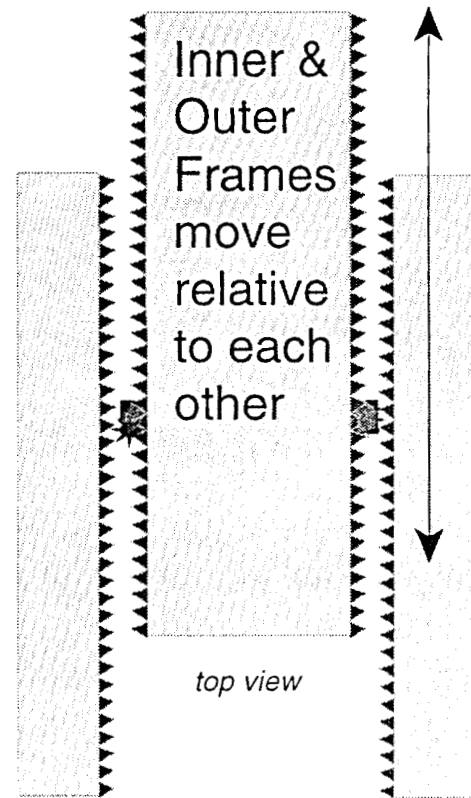
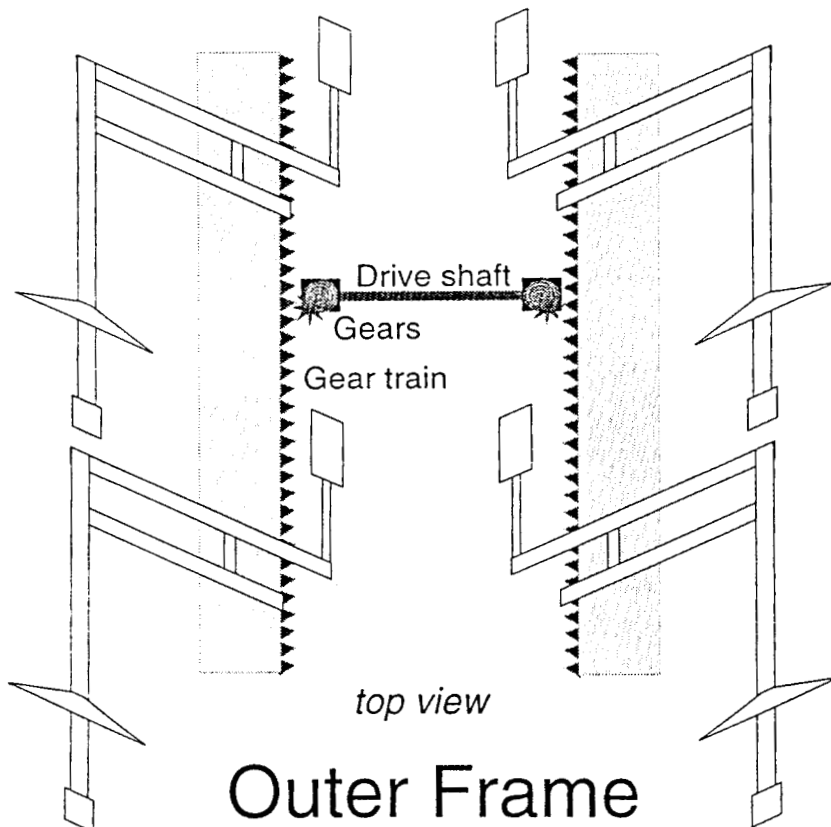
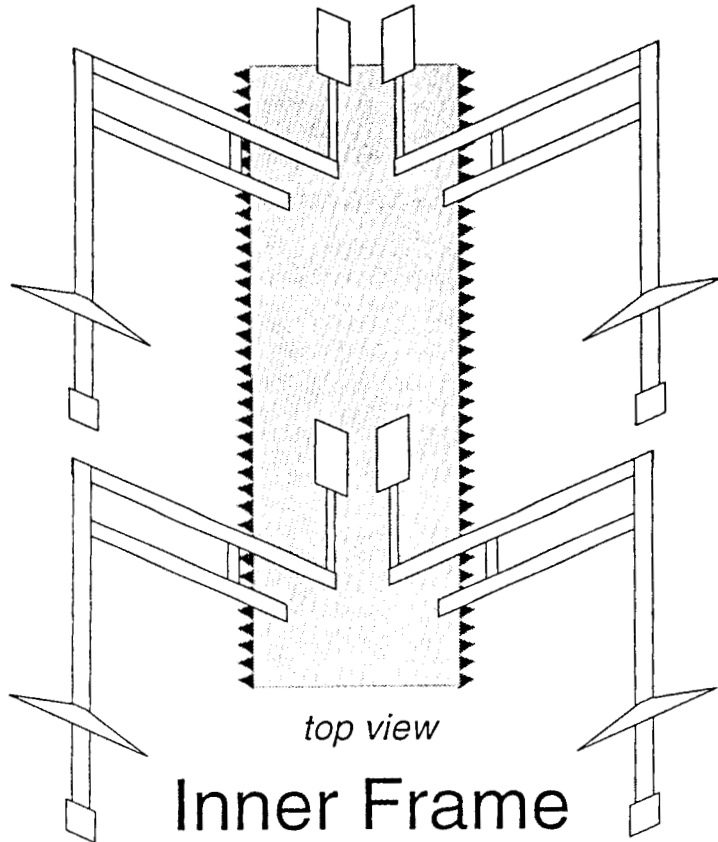
## Dante II leg systems



## Generalized leg schematic and function



## Dante II frame systems



There is a tension and exit angle sensor for the reel-tether system. There are pitch and roll inclinometers which provide information on the overall robot inclination. The laser scanning rangefinder system is a full circle system which describes the distance to reflective (inferred, therefore, to be solid) surfaces in a doughnut-shaped space around the robot. It is accurate to a few centimeters in several dozens of meters (hundredths of an inch in dozens of yards). The information which the scanner provides is cumulative information, which means the robot is building a three-dimensional map of its surroundings as it moves through them.

At the front and back corners of the overall robot frame there is an inward-pointing camera which provides a look at six of the robot's eight legs from an inside-out perspective. The mast also has a stereo-pair camera system which is used for the human operator three-dimensional imaging system. The stereo camera can be panned and tilted on command by the operator. There is also a camera which monitors the tether mechanism.

### **Science Instruments**

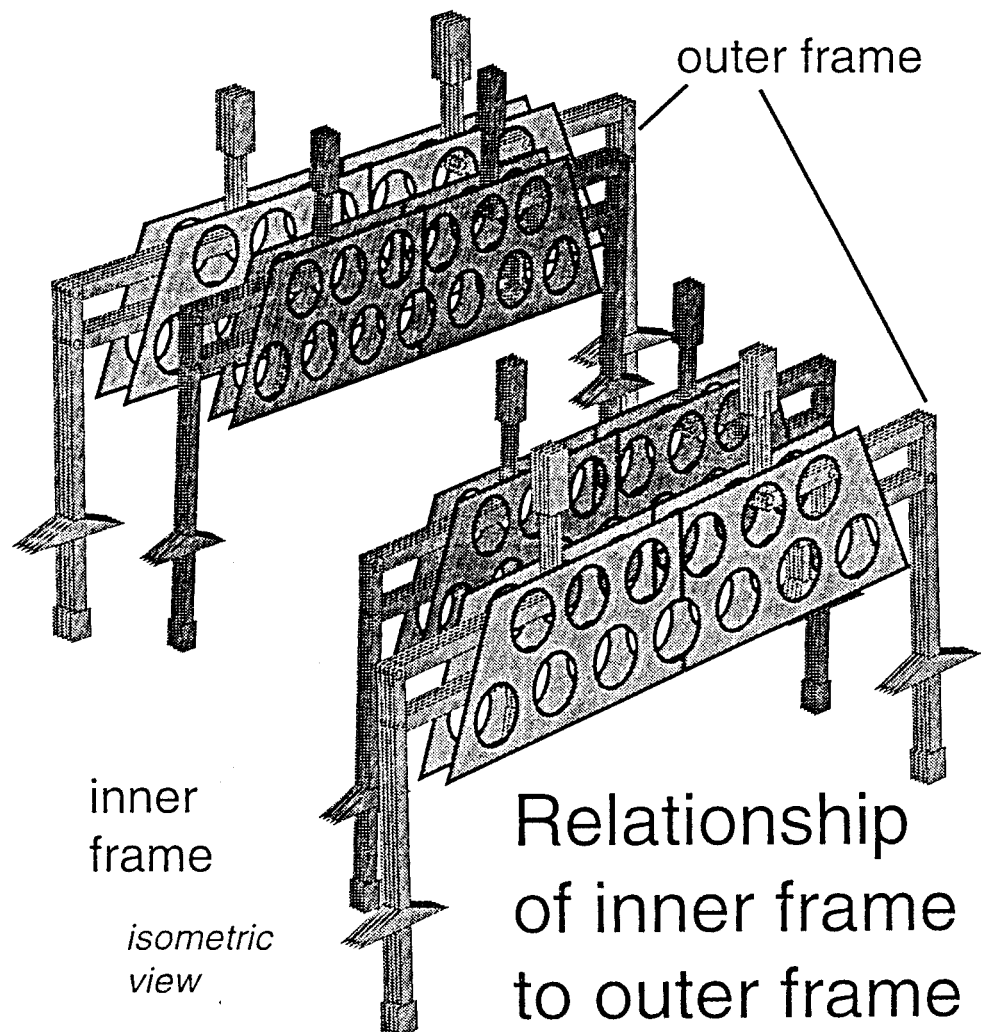
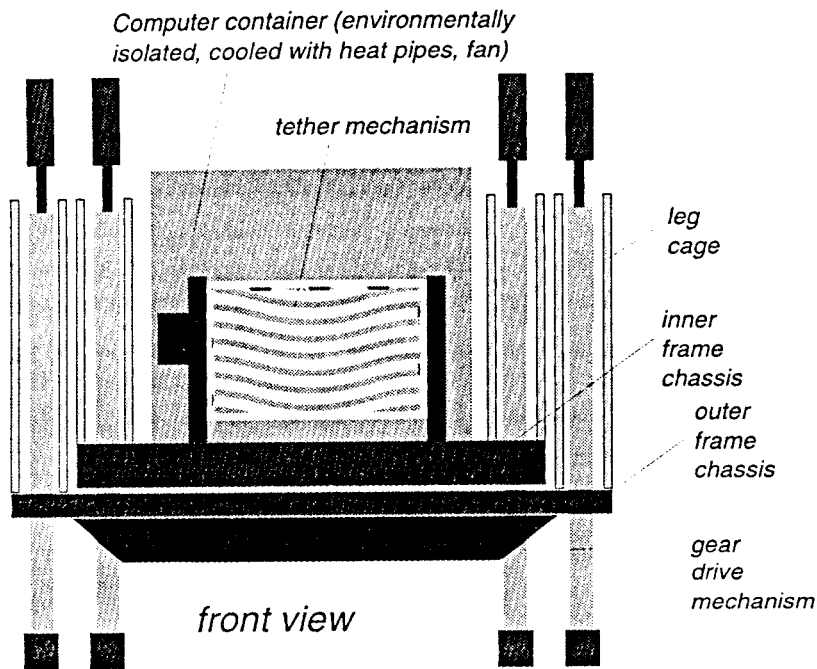
The science instruments on this demonstration were selected after consulting scientists from the Alaska Volcano Observatory, the Cascades Volcano Observatory, and the Hawaii Volcano Observatory. These sensors consist of two thermocouples on one of the robot's forward legs for measuring hot fumarole gases. There is an ambient air temperature gauge, a hydrogen sulfide sensor, and a carbon dioxide sensor. All of the science instruments are operating all the time, producing a stream of data on the temperatures and gaseous compositions of the environment. This data will be available to the robot team and science team members throughout the robot's operations.

In addition, the Eastman Kodak Company has provided a high-resolution, color digital still image camera system which can record up to 50 images in its onboard memory and which are transmitted from the robot through its onboard computer system. The digital images are comprised by 1,496 by 1,024 pixels, each with three eight-bit planes (red, green and blue).

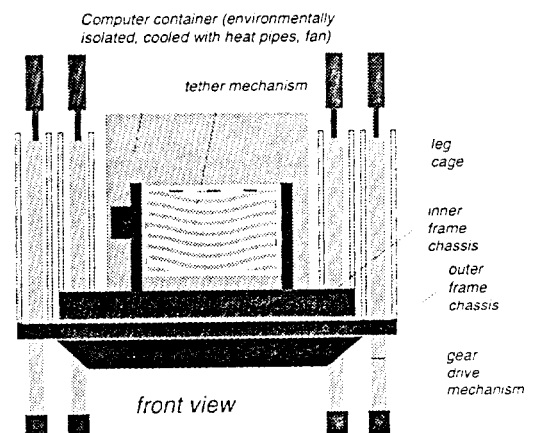
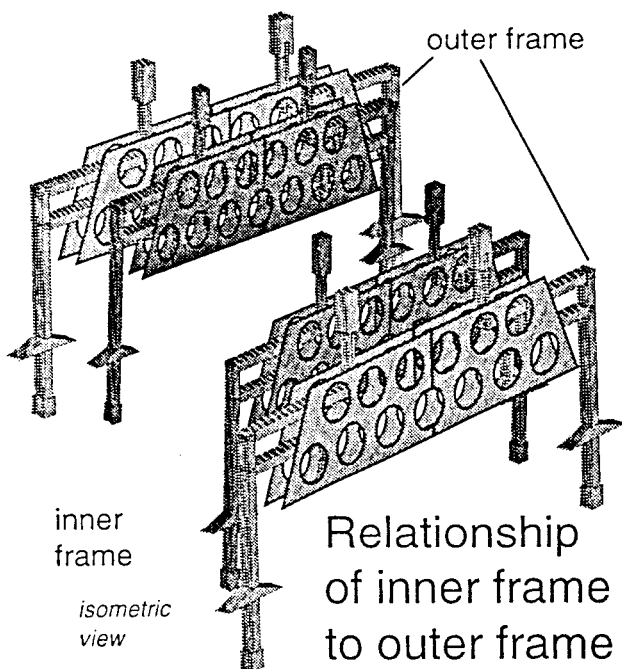
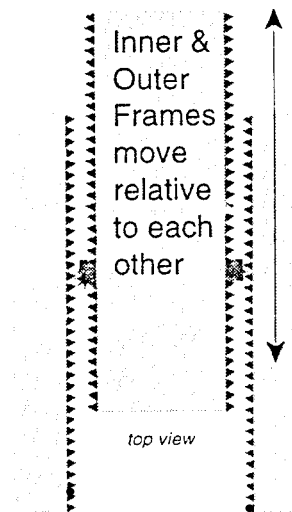
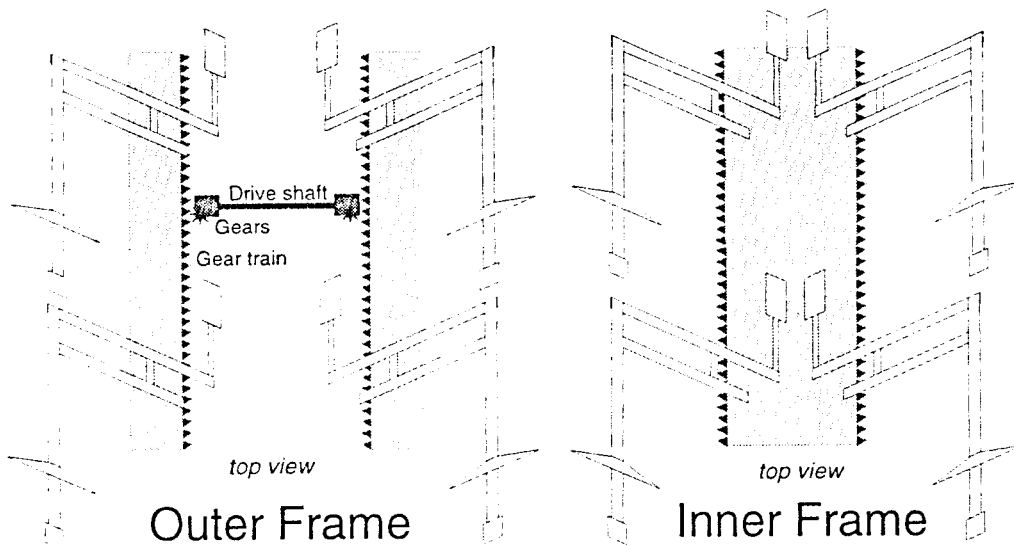
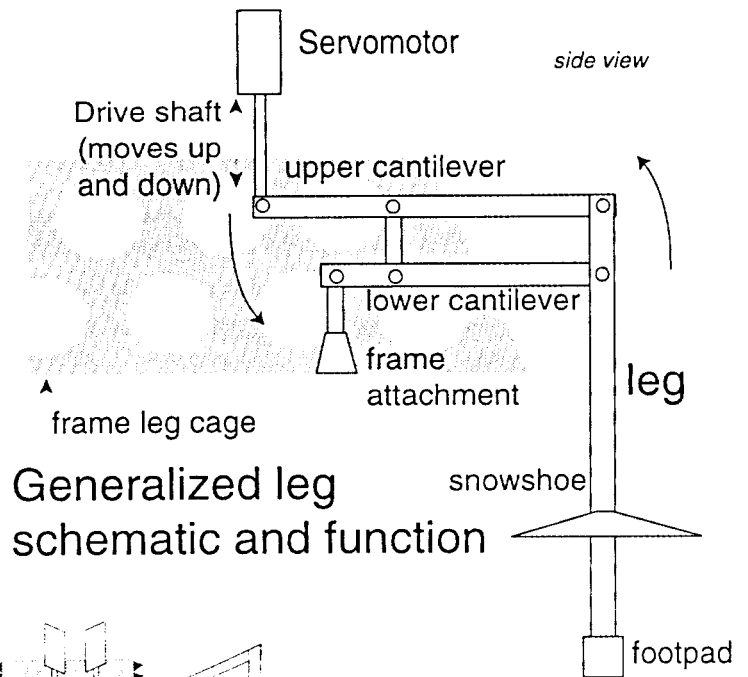
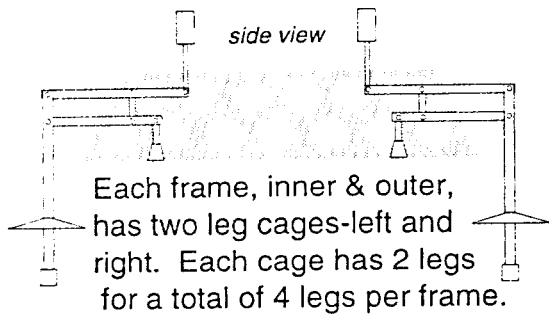
The uncompressed image size is 4.5 megabytes. The camera has an onboard compressor which saves the images at 1.5 megabytes size within the camera. The images are sent from the camera through the robot processor and Ethernet wires to the satellite station for uplinking to the Anchorage control center site. The images will be stored in the camera as they are taken and sent to Anchorage at the conclusion of each day's robot operations. These images will also be used for scientific analysis of the interior structure and overall composition of the crater.

Robot electrical power is provided by a power line which runs through the tether system. The robot has a power conditioning and distribution system which provides a variety of AC and DC voltages to the various onboard systems. The communications from and to the robot is accomplished by using Ethernet protocols sent through the Ethernet wires, also embedded in the tether cord. There are one prime and three backup Ethernet twisted-wire pairs within the tether cord. There are also two onboard radio-frequency transceivers which

## Dante II frame and mechanical systems relationships



# Dante II locomotion and mechanical systems



provide complete and independent redundancy for the robot-to-rim station communications requirements.

Onboard processing is accomplished using a suite of special control cards for the various sensors and actuators. There are three Motorola 68030 processor cards which can be configured in a variety of methods should one fail, but which normally provide walking and maneuvering control to the robot's systems. There is also a Sun Sparc Station processor system which normally processes the laser rangefinder data to build the virtual contour maps which both the robot and its human controllers use for navigation. Any of the various processor systems can be rerouted to provide operational support to the sensors and actuators should one or more of these cards fail.

### **Computer uses standard plug-in cards**

The computer assembly in the onboard environmentally-isolated control box uses industry-standard VME cards and racks to provide both simplicity and ruggedness. Cards in the computer assembly are fairly easily changed should any of them fail (this implies a failure which precludes the robot's descent into the volcano crater. Human safety considerations are expected to eliminate any chance that a card would be replaced once the crater descent begins.)

The robot is controlled through a set of instructions which have been developed by Carnegie Mellon University Robotics Institute software engineers which the Institute calls its Task Control Architecture. These routines are coded and compiled in industry standard Unix or C++ languages. The goal of the team in using these procedures and devices is to make it easy and low-cost for both themselves and potential other users to add on or modify the existing system.

The basic leg actuation system is identical to that used on the Dante I robot. The frame-walking system is new to Dante II. The legs have been stress analyzed and certain sections redesigned and rebuilt. The onboard sensor system is essentially the same as that used for Dante I with some additions and a few deletions. The same holds true for the computation and control system. However, on Dante I the computer system was on the rim and connected to the robot through a communications and power tether system. The Dante II robot has its "brains" mounted on the top of its inner frame.

The sensor mast of Dante II has been redesigned and built new with an added goal of making it easier for humans to climb up and mount or adjust the existing camera and scanner assemblies.

Another big change is the legs on Dante I were anodized a magenta color with major sections of the main robot assembly also magenta. Dante II is a native aluminum in color with the exception of the tether system and computer box, which are painted an iridescent lemon yellow. This new color provides improved visibility of the robot to a camera which will be located at the rim station.

## **Alaska Volcano Observatory**

The Alaska Volcano Observatory is a cooperative organization that monitors Alaska's hazardous volcanoes and supports public safety measures. The monitoring focuses on volcanoes in the Cook Inlet region, Alaska's most populous area and a major international air transportation hub.

This region includes Redoubt Volcano which had major eruptions in 1989-90 and 1965-68, Augustine Volcano which erupted most recently in 1986, but which had previously erupted 1976, 1963, 1935, 1883 and Mt. Spurr which erupted in 1953 and then several times beginning in 1992.

AVO is a joint program of the U.S. Geological Survey (Dept. of Interior), the Geophysical Institute of the University of Alaska Fairbanks, and the State of Alaska Division of Geological and Geophysical Surveys.

This program coordinates federal, state and university resources to provide public safety information, particularly for military, commercial and private aviation. Hazard reduction studies and basic volcanology science are pursued as well by the partners.

The Alaska Volcano Observatory employs satellite and aircraft observations of Aleutian Arc volcanoes and maintains a large network of seismometers on Mt. Spurr and other volcanoes within 200 miles of Anchorage. The types of measurements which AVO takes include gas samples, geochemistry, flood monitoring, ashfall measurements, satellite and aircraft observations which also include gaseous chemical constituent analysis, ash plume trajectory analysis and prediction and geodetic and seismic measurements.

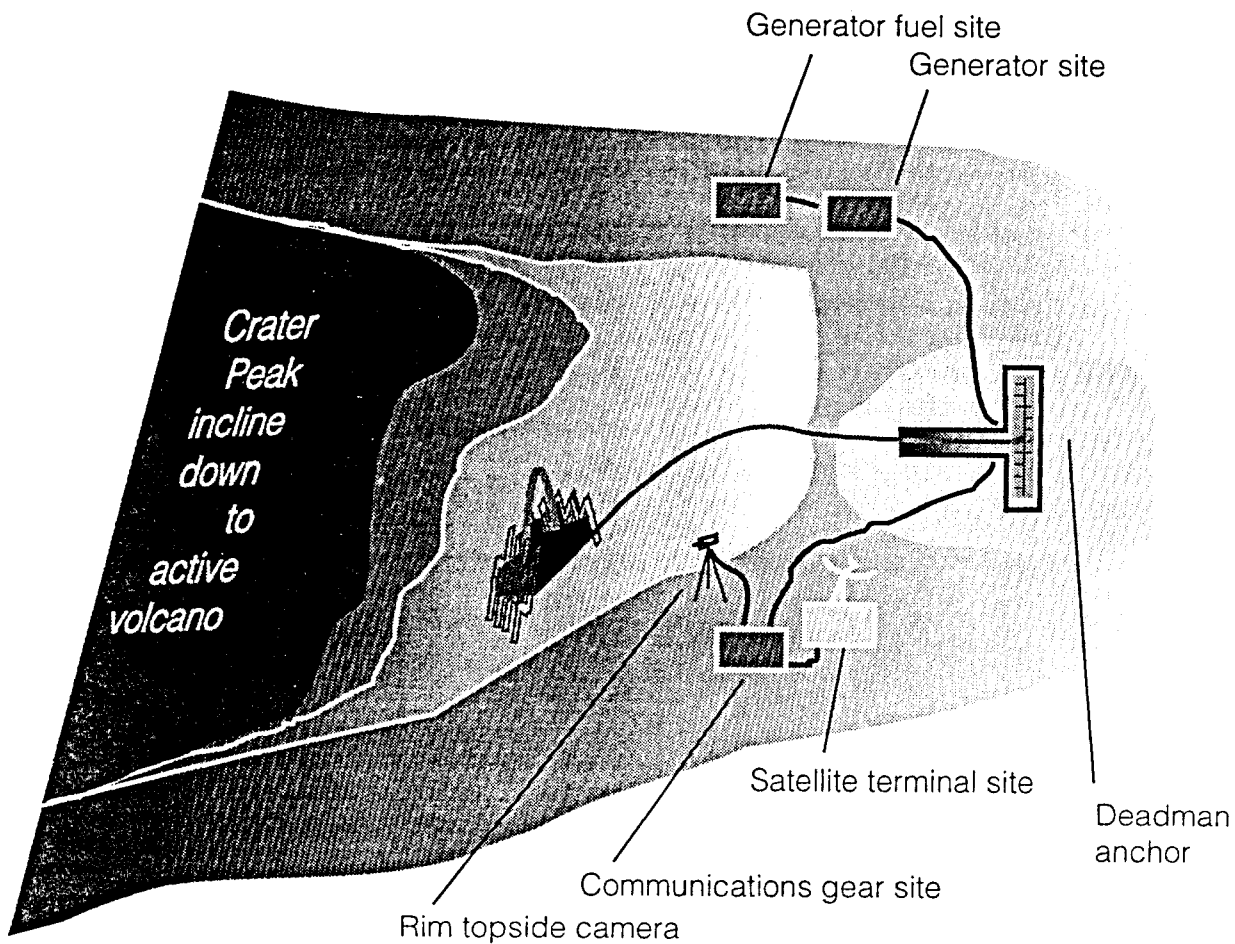
The U.S. Geological Survey office in Anchorage acts as the voice of the AVO during periods requiring warning. The scientist-in-charge of the USGS office is Terry Keith. The main seismology laboratory is at the University of Alaska Fairbanks Geophysical Institute. These offices use voice and computer communications networks to maintain coordination with each other and are also connected, via computer network, to other USGS volcanology laboratories in Washington state and California.

The Mt. Spurr team will be in radio contact with geologists at the Anchorage office of the AVO for information on seismic and other signals of volcanic unrest. In the event of any information suggesting impending volcanic eruption, the Dante team will be immediately removed from the rim.

### **Mt. Spurr Volcano**

Most Alaskan volcanoes are in the Aleutian arc which extends about 1,550 miles along the southern edge of the Bering Sea and Alaskan mainland. This classic volcanic arc contains some 80 Quaternary period (see Geologic Time Scale chart at end of section) stratovolcanoes and calderas. These 80 volcanoes have all been active within the last two-and-a-half million years.

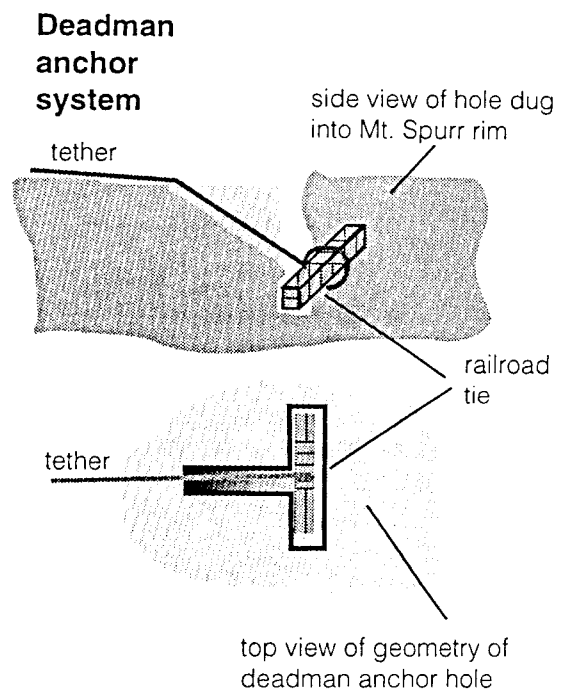
## Rim area of Mt. Spurr Crater Peak



First team on rim will determine sites for the various components and dig deadman anchor hole

### Sequence of actions:

1. Select site for anchor
2. Select site for satellite dish
3. Run cable for dish
4. Mark Dante II site
5. Install anchor
6. Install ground rod
7. Select and wire rim camera site
8. Select and mark sites for generator, fuel storage tank, communications and satellite antenna



Aleutian arc volcanism is the result of active subduction of the Pacific Plate beneath the North American Plate. The 5,440-mile-long Aleutian trench that extends from the northern end of the Kamchatka trench to the Gulf of Alaska marks the boundary between the two plates.

The Aleutian volcanic arc contains 44 of the 54 historically active volcanoes in the United States. In the last decade, there has been hardly a year which has not seen a volcanic eruption in the Aleutian chain. This is probably not the result of increased activity in the chain, but rather the result of improved detection and monitoring.

The Spurr volcanic complex consists of an ancestral volcano whose growth was terminated by the formation of an avalanche caldera. The present Mt. Spurr then grew in the center of the caldera and the active Crater Peak grew in the breach.

The ancestral volcano is some 11.9 miles in diameter and was constructed in the late Pleistocene era, about a quarter-of-a-million years ago. That era was the earlier of the two epochs of the Quaternary period which was characterized by the alternate appearance and recession of northern glaciation and the appearance of the progenitors of human beings. The geologic era we are in now is called the Holocene epoch.

The base elevation of the volcano ranges from about 400 feet in the south to nearly 6,500 feet to the northwest. Maximum height of the remains of the ancestral volcano above sea level is 8,125 feet. Snow and ice obscure much of the northern flanks of the volcano, but the southern flank is well exposed. It is on this flank that the Crater Peak eruption site lies.

The lower portions of the volcano's structure is dominated by deposits of thick ash flows and other pyroclastic deposits. The upper reaches are dominated by lava flows, most of which are between 150,000 and 50,000 years old.

The historic cone growth was terminated during the very late Pleistocene or early Holocene epochs by the avalanche formation of a caldera. The caldera is 3.1 by 5.0 miles across and contains an ice field which feeds glaciers which drain in all directions.

The Crater Peak cone grew in the breach of the ancestral volcano and grew at the same time as the Mt. Spurr dome, which now reaches 11,070 feet. On July 9, 1953, Crater Peak erupted with no warning. The eruption cloud reached an altitude in excess of 13.1 miles and deposited nearly a third of an inch of ash on Anchorage - 80 miles to the east. At that time, Crater Peak's crater was ice-filled and there were no active fumaroles.

On June 27, 1992, the Crater Peak vent awoke again after 39 years of dormancy and burst into eruption after 10 months of elevated seismic activity. Two more eruptions followed in August and September.

Alaska Volcano Observatory science analysis of these eruptions has produced a conclusion that all four eruptions share a commonality with regard to the duration of the eruption and the volume of the material ejected or vented. What is not shared is the concurrent seismic activity of the four events, which presents forecasters with a vexing problem and therefore requirements for additional data about the volcano.

#### **Geological Time Scale**

<b>Era</b>	<b>Period</b>	<b>Epoch</b>	<b>Absolute Age, starting</b>
Cenozoic	Quaternary	Holocene	11,000 years ago
		Pleistocene	2,000,000 years ago
	Tertiary	Pliocene	8,000,000 years ago
		Miocene	26,000,000 years ago
		Oligocene	37,000,000 years ago
		Eocene	53,000,000 years ago
		Paleocene	70,000,000 years ago
Mesozoic	Cretaceous		135,000,000 years ago
	Jurassic		190,000,000 years ago
	Triassic		230,000,000 years ago
Paleozoic	Permian		280,000,000 years ago
	Pennsylvanian		310,000,000 years ago
	Mississippian		350,000,000 years ago
	Devonian		400,000,000 years ago
	Silurian		430,000,000 years ago
	Ordovician		500,000,000 years ago
	Cambrian		600,000,000 years ago
Precambrian			3,500,000,000 years ago
Origin of Earth			4,600,000,000 years ago

#### **Volcanoes and Global Climate Change**

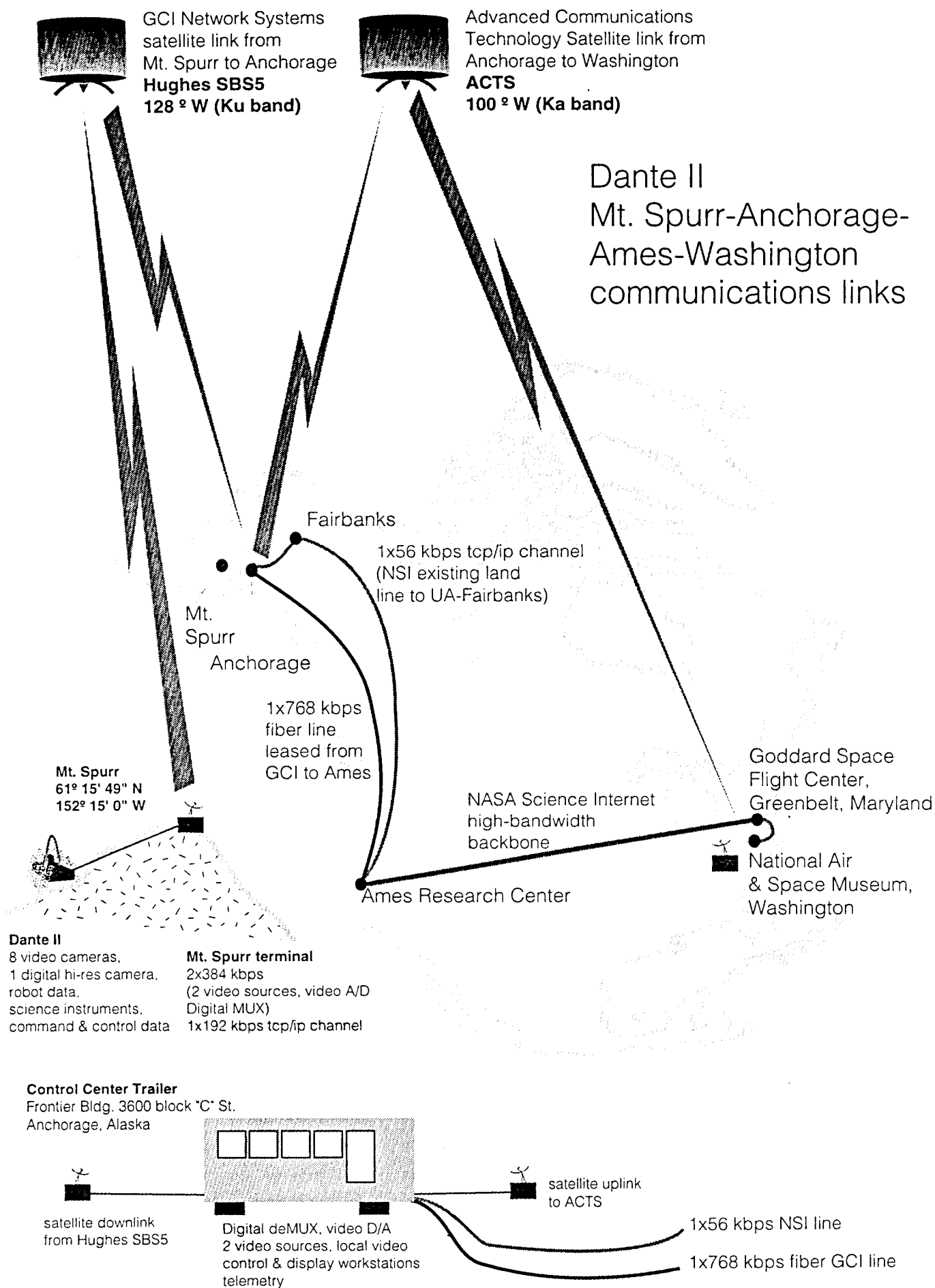
Volcanic eruptions are thought to be responsible for the global cooling that has been observed for a few years after a major eruption. The amount and global extent of the cooling depend on the force of the eruption and, possibly, its latitude. When large masses of gases from the eruption reach the stratosphere, they can produce a large, widespread cooling effect. As a prime example, the effects of Mount Pinatubo, which erupted in June 1991, may have lasted a few years, serving to offset temporarily the predicted greenhouse effect.

As volcanoes erupt, they blast huge clouds into the atmosphere. These clouds are made up of particles and gases, including sulfur dioxide. Millions of tons of sulfur dioxide gas can reach the stratosphere from a major volcano. There, the sulfur dioxide converts to tiny persistent sulfuric acid (sulfate) particles, referred to as aerosols. These sulfate particles reflect energy coming from the sun, thereby preventing the sun's rays from heating the Earth.

Global cooling often has been linked with major volcanic eruptions. The year 1816 often has been referred to as "the year without a summer." It was a time of significant weather-related disruptions in New England and in Western Europe with killing summer frosts in the United States and Canada. These strange

phenomena were attributed to a major eruption of the Tambora volcano in 1815 in Indonesia. The volcano threw sulfur dioxide gas into the stratosphere, and the aerosol layer that formed led to brilliant sunsets seen around the world for several years.

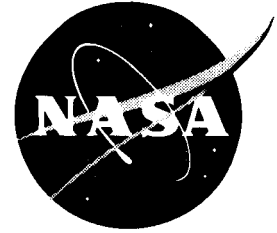
However, there is some confusion about the historical evidence that global cooling may be caused by volcanic emissions. Two recent volcanic eruptions have provided contradictory evidence on this point. Mount Agung in 1963 apparently caused a considerable decrease in temperatures around much of the world, whereas El Chichn in 1982 seemed to have little effect, perhaps because of its different location or because of the El Nino that occurred the same year. El Nino is a Pacific Ocean phenomenon, but it causes worldwide weather variations that may have acted to cancel out the effect of the El Chichn eruption.



# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 358-1600



For Release

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July 7, 1994

Jim Elliott  
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Ray Villard  
Space Telescope Science Institute, Baltimore, Md.  
(Phone: 410/338-4154)

RELEASE: 94-109

## **HUBBLE DETECTS PRIMORDIAL HELIUM IN THE EARLY UNIVERSE**

An international team of astronomers has used the European Space Agency's (ESA's) Faint Object Camera (FOC) on the Hubble Space Telescope (HST) to confirm a critical prediction of the Big Bang cosmological theory -- that the chemical element helium should be widespread in the early universe.

The detection of this helium by HST may mark the discovery of a tenuous plasma that fills the vast volumes of space between the galaxies -- the long-sought after intergalactic medium.

The new findings also shed light on the physical conditions that existed in intergalactic space at a time when the universe was only a tenth of its present age, and quasars and galaxies had only recently formed.

The discovery follows from work done by a team of European astronomers, led by ESA's project scientist for the FOC, Dr. Peter Jakobsen. The FOC was used as a spectrograph to analyze the ultraviolet light received from a very distant quasar.

Reporting in the July 7, 1994, issue of the British science journal Nature, the group describes how the helium was detected in the light of a remote celestial body, a quasar, located in the constellation of Cetus at a distance so great that its light has taken some 13 billion years, or 90% of the age of the universe, to get to us.

- more -

By showing that significant amounts of helium existed in the early universe at a time when it was only a tenth as old as today, the discovery reaffirms the explanation of the formation of the chemical elements in the universe. Hydrogen and helium were formed in the first three minutes after the Big Bang by reactions between the primordial protons and neutrons. The heavier elements (carbon, oxygen, silicon, iron, etc.,) came only later through nuclear reactions in the centers of stars.

The Hubble Space Telescope is a project of international cooperation between NASA and ESA.

The scientific team responsible for this research includes Drs. Peter Jakobsen of ESA/ESTEC, The Netherlands; Alec Boksenberg of the Royal Greenwich Observatory, U.K.; Jean-Michel Deharveng of Laboratoire d'Astronomie Spatiale, France; and Perry Greenfield, Robert Jedrzejewski and Francesco Paresce, all working on the ESA FOC at the Space Telescope Science Institute, Baltimore, Md.

- end -

**NOTE TO EDITORS:** For more details on this finding, please refer to ESA Press Information Note 17-94, available in the U.S. from the Washington, D.C., ESA office: 202/488-4158.

For specific technical information, media representatives may call:

In the U.S., Dr. Francesco Paresce (ESA/STScI) 410/338-4823;

In The Netherlands, Dr. Peter Jakobsen (ESA/ESTEC)  
31-171983614.

For general background information, media representatives may call:

Dr. Edward Weiler (NASA) 202/358-0351.

# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
AC 202 358-1600



For Release

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July 6, 1994

Kyle Herring  
Johnson Space Center, Houston  
(Phone: 713/483-5111)

RELEASE: 94-110

## **SHUTTLE ASTRONAUT RICHARD COVEY TO LEAVE NASA, AIR FORCE**

Richard O. Covey, (Colonel, USAF), a veteran of four Space Shuttle flights, including last year's mission to service the Hubble Space Telescope, will leave NASA effective July 11 and retire from the U.S. Air Force on August 1.

After 16 years with NASA as an astronaut, Covey is joining Calspan Services Contracts Division, an operating unit of Space Industries, Inc., as Director of Business Development in Houston.

Selected as a member of the astronaut class of 1978, Covey has flown four times on the Shuttle. He flew twice aboard Discovery on STS-51-I and STS-26, once on the STS-38 mission of Atlantis and Endeavour's STS-61 flight.

Prior to his first flight, Covey provided astronaut support in Orbiter engineering development and testing. He was a T-38 chase pilot for the second and third Shuttle flights and served as a spacecraft communicator (CAPCOM) in Mission Control during several other missions.

His first Shuttle flight (STS-51-I) was in August 1985 and included deployment of three communications satellites and the retrieval, repair and redeployment of another. Covey's second mission (STS-26) in September 1988 was the first following the Challenger accident and included deployment of a NASA communications satellite. The STS-38 mission was a dedicated Department of Defense flight in November 1990 and was Covey's third spaceflight.

Covey most recently commanded the STS-61 mission in December 1993 which included five spacewalks to service and repair the Hubble Space Telescope for the first time.

- more -

"Dick's dedication to this nation's space effort is an asset we will miss," said David C. Leestma, director of Flight Crew Operations at the Johnson Space Center. "Since being selected as part of the first group of astronauts chosen for the Space Shuttle program in 1978, Dick has proven his worth to the aerospace community with near unparalleled leadership and will no doubt succeed in all of his future endeavors."

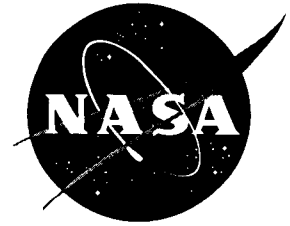
Covey has flown more than 30 different types of aircraft accumulating over 5,700 hours of flight time. Between 1970 and 1974, he was an operational fighter pilot flying F-100, A-37 and the A-7D. He flew 339 combat missions during two tours in Southeast Asia. Prior to being selected as an astronaut, Covey was an F-4 and A-7D weapons system test pilot and joint test force director for electronic warfare testing of the F-15 Eagle at Eglin Air Force Base in Florida between 1975 and 1978.

From Fort Walton Beach, Florida, Covey, 47, graduated from the U.S. Air Force Academy with a bachelor of science degree in engineering sciences and a major in astronautical engineering in 1968. He received a master of science degree in aeronautics and astronautics from Purdue University in 1969.

# NASA News

National Aeronautics and  
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For Release

July 7, 1994

Brian Dunbar  
Headquarters, Washington, D.C.  
(Phone: 202/358-0873)

RELEASE: C94-y

## **BROWN & ROOT SERVICES CORP. SELECTED TO NEGOTIATE CONTRACT**

NASA has selected Brown & Root Services Corp., Houston, Texas, to negotiate a fixed-price-award-fee, indefinite quantity, delivery order contract. Brown & Root will provide minor construction, modification and rehabilitation to NASA Goddard Space Flight Center (GSFC), Greenbelt, Md. The estimated contract value is \$100 million.

This 5-year contract (1-year basic period and two 2-year option periods) is to support GSFC's Facilities Management Division. The basic contract period will be from Sept. 1, 1994 through Aug. 31, 1995.

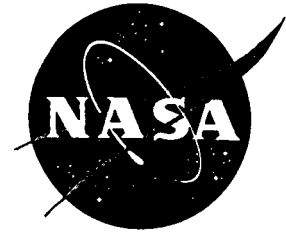
Proposals also were submitted by the following companies: Centennial Contractors Enterprises, Inc.; J.A. Jones Management Services, Inc.; Ogden Services Corp.; Harbert Yeargin, Inc.; Leapley Company, Inc.; Holmes & Narver Construction Services, Inc.; M&B Construction Services; Sverdrup Facilities, Inc.; Trataros Construction, Inc.; C.E.R., Inc.

-end-

# NASA News

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202 358-1600



For Release

July 7, 1994

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Headquarters, Washington, D.C.  
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NOTE TO EDITORS: N94-50

## **NEW HUBBLE IMAGES OF COMET SHOEMAKER-LEVY 9 AVAILABLE**

Three recent images of Comet P/Shoemaker-Levy 9 and Jupiter taken by NASA's Hubble Space Telescope are available to news media representatives. The first image is a "true color" picture of the planet Jupiter in detail, surpassed only by images from spacecraft which traveled to the planet. The photo numbers are: color--94-HC-171; B&W--94-H-185.

The second image is the latest of Comet P/Shoemaker-Levy 9, taken on May 17, 1994, showing the train of 21 fragments stretched across 710,000 miles of space. The photo numbers are: color--94-HC-172; B&W--94-H-186.

The third image is a photo illustration assembled from separate images of Jupiter and Comet P/Shoemaker-Levy 9, showing the planet and comet in close proximity as it should appear shortly before the comet fragments begin impacting the giant planet on July 16. One by one, the comet fragments will impact Jupiter during the week of July 16-22. The photo numbers are: color--94-HC-170; B&W--94-H-184.

The first fragment, one of the smallest of the comet's fragments, will impact Jupiter just before 4 p.m. EDT, July 16, on the side of Jupiter facing away from Earth. Shortly afterwards, the point of impact will rotate into view as seen from Earth.

Because of its small size, most scientists do not expect to witness significant visible effects from the impact of the first fragment, nor to detect significant after-effects in the planet's atmosphere. However, there is a greater possibility of detectable effects resulting from the impacts of larger fragments later during the week. Some of the effects scientists will be looking for in the Jovian atmosphere are small changes in cloud structure as well as small changes in the temperature structure, which can be measured using infrared telescopes.

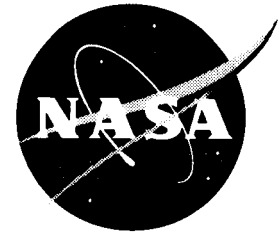
Media representatives can obtain the images by calling the NASA Headquarters Broadcast and Imaging Branch at 202/358-1900. Also, an updated listing of the comet fragment impact times and viewing locations is available by contacting the Newsroom at 202/358-1600.

- end -

# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 358-1600



For Release

David E. Steitz  
Headquarters, Washington, D.C.  
(Phone: 202/358-1730)

July 8, 1994

RELEASE: 94-111

## 15 ADDITIONAL 1994 PHASE ONE STTR SELECTIONS ANNOUNCED

NASA announced today that it will negotiate contracts to enable 15 small companies to fully develop innovative new high technology products they have proposed for application in the aerospace industry.

The announcement brings to 21 the number of projects that will be financed under the agency's Small Business Technology Transfer Program (STTR) which is managed by NASA's Office of Advanced Concepts and Technology.

The STTR program is similar to the Small Business Innovative Research program but varies by allowing universities, federal laboratories and non-profit organizations to apply in cooperation with small business partners. The STTR program also is more directly aimed at private sector commercialization activities.

The 21 contracts are known as Phase I contracts which focus on product development. Success in Phase I will lead to Phase II which is geared toward product commercialization. The Phase II award process allows for two-year, fixed price contracts up to \$500,000.

The 1994 Phase I solicitation closed on March 3, 1994. One hundred fifty-nine separate proposals were received from 137 small, high technology businesses in conjunction with universities from all sections of the United States in response to the three topics in the solicitation.

Experts from NASA's Goddard Space Flight Center, Greenbelt, Md., and Langley Research Center, Hampton, Va., academia, and commercial businesses reviewed the proposals for technical merit and commercial potential. Each of the fifteen selected proposals in this round will be awarded fixed-price contracts valued at up to \$100,000 with 12 months to complete the Phase I projects.

A listing of the fifteen selected research proposals by firm name, address, and proposal number may be obtained by calling the NASA Headquarters Newsroom at (202/358-1600).

- end -

# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 358-1600



Ed Campion  
Headquarters, Washington, D.C.  
(Phone: 202/358-1778)

For Release

July 7, 1994

Kyle Herring  
Johnson Space Center, Houston  
(Phone: 713/483-5111)

RELEASE: 94-112

## **CREW NAMED FOR SECOND WAKE SHIELD FACILITY SHUTTLE FLIGHT**

U.S. Navy Captain David M. Walker will command Endeavour's ninth mission, STS-69, scheduled for mid-1995. The primary objective of the flight will be to deploy and retrieve the Wake Shield Facility (WSF) first flown on the STS-60 mission in February 1994.

Walker's crewmates on the STS-69 mission are Kenneth D. Cockrell, pilot, and James H. Newman and Michael L. Gernhardt, mission specialists. James S. Voss (Lt. Col., USAF) was named payload commander in August 1993.

The STS-69 mission will mark the second flight of the Wake Shield Facility. WSF is designed to evaluate the effectiveness of using this free-flying experiment to grow semiconductors, high temperature superconductors and other materials using the ultra-high vacuum created behind the spacecraft near the experiment package.

The mission also will include the Office of Aeronautics and Space Technology free flyer (OAST Flyer) which will be deployed from the Shuttle containing several space technology experiments. A small experiment designed to study ultraviolet emissions, called the International Extreme Ultraviolet, Far Ultraviolet Hitchhiker (IEH), will be part of the payload complement as well.

Walker will be making his fourth flight aboard the Shuttle. His first mission was as pilot of the STS 51-A flight aboard Discovery in November 1984. Two communications satellites were deployed and two others retrieved and returned to Earth during that mission.

- more -

His second mission was as commander of Atlantis' STS-30 mission in May 1989 to deploy the Magellan spacecraft that continues to study the surface of Venus. Walker's third flight was aboard Discovery on the STS-53 mission in December 1992. The primary goal was to deploy a classified Department of Defense payload (DOD-1).

Walker, 50, has been the Flight Crew Operations Directorate's primary liaison to the Space Station program as Chief, Station Exploration Support Office. He is from Eustis, Fla., and is a 1966 graduate of the U.S. Naval Academy.

STS-69 will be the second Shuttle mission for 44-year-old Cockrell. His first flight was aboard Discovery on the STS-56 mission in April 1993. The mission focused on better understanding the effects of solar activity on the Earth's environment using a series of instruments in the payload bay that made up the Atmospheric Laboratory for Applications and Science (ATLAS-2).

Prior to this assignment, Cockrell has been serving as a spacecraft communicator (CAPCOM) in Mission Control during launch and landing. He was born in Austin, Texas. He received a master of science degree in aeronautical systems from the University of West Florida in 1974.

Newman, 37, will also be making his second spaceflight. He previously flew as a mission specialist on STS-51 aboard Discovery in September 1993. The mission included deployment of the Advanced Communications Technology Satellite (ACTS) and deployment/retrieval of a science platform to study ultraviolet emissions. Newman also conducted a spacewalk to test tools and techniques for use on future missions.

From San Diego, Calif., Newman received his doctorate in physics from Rice University in 1984. Since his last mission, he has been assigned to the Mission Development Branch working on payload science support.

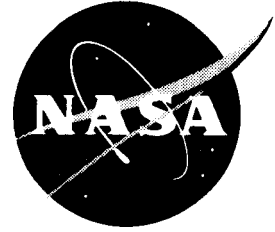
Gernhardt, 38, will be making his first Shuttle flight. He was born in Mansfield, Ohio, and received his doctorate in bioengineering from the University of Pennsylvania in 1991.

Prior to this assignment, Gernhardt has been detailed to flight software verification in the Shuttle Avionics Integration Laboratory (SAIL). He also has worked on several extravehicular activity (EVA) projects, including direct support for last year's mission to service the Hubble Space Telescope (STS-61).

# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
AC 202 358-1600



For Release

Donald L. Savage  
Headquarters, Washington, D.C.  
(Phone: 202/358-1547)

July 8, 1994

Keith Kohler  
Wallops Flight Facility, Wallops Island, Va.  
(Phone: 804/824-1579)

RELEASE: 94-113

## **NASA Selects Participants for Student Launch Program**

NASA has selected two Space Grant Consortiums and two universities to participate in the Student Launch Program. This program will provide undergraduate students hands-on education with the opportunity to fly space and Earth science experiments on suborbital sounding rockets and scientific balloons.

The purpose of the program is to provide undergraduate students with an opportunity to gain experience in all aspects of suborbital missions including planning, management, design, fabrication, payload testing, qualification, and field operations associated with experiments for spaceflight.

The program provides students with the opportunity to participate actively in carrying out spaceflight experiments, increasing their awareness of the complex nature of such activities and stimulating continued interest in pursuing careers in engineering and science. The program emphasizes participation by underrepresented student groups, including persons with disabilities.

The participants and their proposed projects are:

### **Virginia Space Grant Consortium**

Hampton University, Old Dominion University and the College of William and Mary will work together on the Virginia Student Upper-Atmospheric Balloon Payload System. A 200,000 cubic feet (5,664 cubic meter) balloon will carry the Virginia payload to gather scientific data on atmospheric temperature and velocity fluctuation levels and data on atmospheric constituent gases.

- more -

### **Colorado Space Grant Consortium**

The consortium will fly an experiment called "Hands-On Education and Research of Ozone (HERO)" on a single-stage Orion sounding rocket. The experiment is designed to accurately measure the total atmospheric ozone over the rocket range; aid in the calibration of ozone satellites; and flight demonstrate advanced techniques for measuring total ozone on future satellites. Universities participating in the project include the University of Colorado at Boulder, the University of Southern Colorado, Fort Lewis College, Colorado State University, University of Colorado at Colorado Springs, Mesa State College and the U.S. Air Force Academy.

### **University of Pennsylvania**

The University of Pennsylvania, with Lincoln University and Gettysburg College, will develop and fly a system for imaging star fields and detecting Cerenkov radiation generated by cosmic rays and pair-producing gamma rays in the upper atmosphere. This system also will fly on a 200,000 cubic feet balloon. This project is supported in part by the Delaware Space Grant Consortium.

### **University of Cincinnati**

The university will fly its experiment on a two-stage Nike-Orion sounding rocket. The launch will carry an ultraviolet spectrometer to investigate absorption of solar energy by ozone, oxygen, and atomic oxygen in the lower thermosphere and mesosphere. The science objective is to determine the concentration of these gases from the spectroscopic measurements.

Through the Goddard Space Flight Center's Wallops Flight Facility, Wallops Island, Va., NASA will provide the rockets and balloons, launch services, technical consultation and guidance.

The participating institutions are responsible for funding the payload hardware and related activities such as fabrication, testing and travel. In addition, the universities will receive technical assistance from industry and other NASA centers.

The suborbital program offers students an opportunity to see projects through from inception to launch in a relatively short time. The flights are planned to be launched from the Wallops Flight Facility in 1995 and 1996.

The Student Launch Program is sponsored by the Office of Space Science, the Office of Human Resources and Education, and the Office of Equal Opportunity at NASA Headquarters, Washington, D.C.

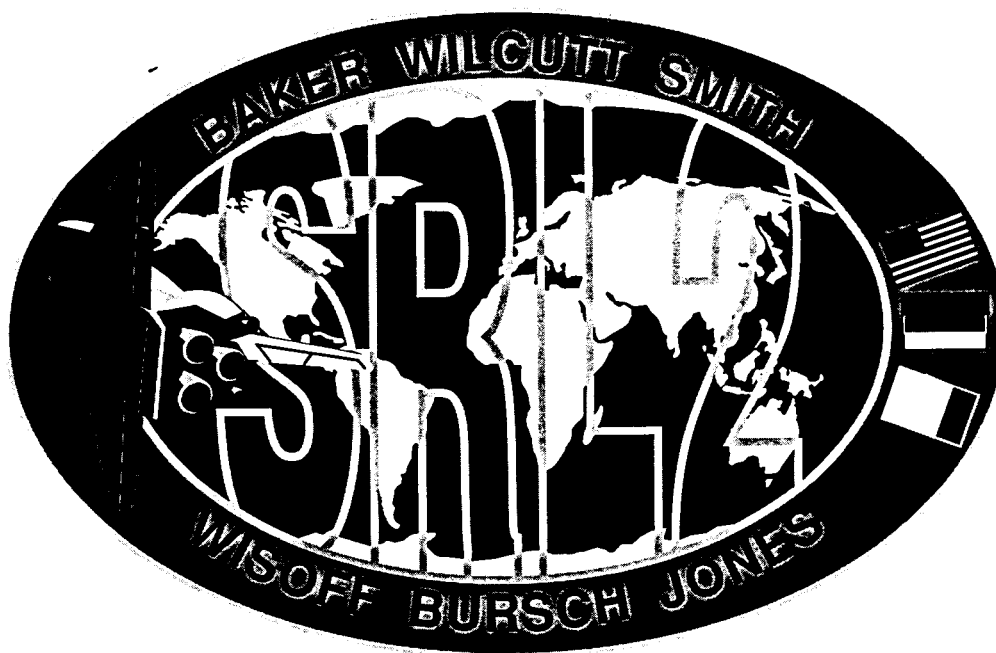
94-114

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

# SPACE SHUTTLE MISSION

**STS-68**

**PRESS KIT  
AUGUST 1994**



**SPACE RADAR LABORATORY-2**

## **PUBLIC AFFAIRS CONTACTS**

### **For Information on the Space Shuttle**

Ed Campion Headquarters, Wash., D.C.	Policy/Management	202/358-1778
James Hartsfield Johnson Space Center, Houston	Mission Operations/Astronauts	713/483-5111
Bruce Buckingham Kennedy Space Center, Fla.	Launch Processing KSC Landing Information	407/867-2468
June Malone Marshall Space Flight Center, Huntsville, Ala.	External Tank/SRBs/SSMEs	205/544-0034
Don Haley Dryden Flight Research Center, Edwards, Calif.	DFRC Landing Information	805/258-3448

### **For Information on NASA-Sponsored STS-68 Experiments**

Brian Dunbar Headquarters, Wash., D.C.	SRL-2	202/358-1547
Mike Braukus Headquarters, Wash., D.C.	BRIC, CHROMEX	202/358-1979
Debra Rahn Headquarters, Wash., D.C.	International Cooperation	202/358-1639
Charles Redmond Headquarters, Wash., D.C.	CPCG	202/358-1757
Tammy Jones Goddard Space Flight Center, Greenbelt, Md.	GAS Experiments	301/286-5566

### **For Information on DOD-Sponsored STS-68 Experiments**

Dave Hess Johnson Space Center, Houston	CREAM, MAST	713/483-3498
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RELEASE: 94-114

## **SPACE RADAR LABORATORY MAKES SECOND FLIGHT**

In August 1994, scientists around the world will again be provided a unique vantage point for studying how the Earth's global environment is changing when Endeavour begins the STS-68 Space Shuttle mission. During the 10 day mission, the Space Radar Laboratory (SRL) payload in Endeavour's cargo bay will make its second flight. The SRL payload, which first flew during STS-59 in April 1994, will again give scientists highly detailed information that will help them distinguish between human-induced environmental changes and other natural forms of change. NASA will distribute the data to the international scientific community so that this essential research is available worldwide to assist people in making informed decisions about protecting the environment.

Leading the STS-68 crew will be Mission Commander Michael A. Baker, who will be making his third flight. Pilot for the mission is Terrence W. Wilcutt, who is making his first flight. The four mission specialists aboard Endeavour are Thomas D. Jones, the Payload Commander, who will be making his second flight; Steven L. Smith who will be making his first flight; Daniel W. Bursch, who will be making his second flight; and Peter J.K. Wisoff, who will be making his second flight.

Launch of Endeavour currently is scheduled for no earlier than August 18, 1994, at 6:54 a.m. EDT. The planned mission duration is 10 days, 4 hours, 40 minutes. With an on-time launch on August 18, Endeavour's landing would take place at 11:34 a.m. EDT on August 28 at the Kennedy Space Center's Shuttle Landing Facility.

The SRL payload is comprised of the Spaceborne Imaging Radar-C/X-Band Synthetic Aperture Radar (SIR-C/X-SAR), and the Measurement of Air Pollution from Satellite (MAPS). The German Space Agency (DARA) and the Italian Space Agency (ASI) are providing the X-SAR instrument.

The imaging radar of the SIR-C/X-SAR instruments has the ability to make measurements over virtually any region at any time, regardless of weather or sunlight conditions. The radar waves can penetrate clouds, and under certain conditions, also can "see" through vegetation, ice and extremely dry sand. In many cases, radar is the only way scientists can explore inaccessible regions of the Earth's surface.

The SIR-C/X-SAR radar data provide information about how many of Earth's complex systems—those processes that control the movement of land, water, air and life—work together to make this a livable planet. The science team particularly wants to study the amount of vegetation coverage, the extent of snow packs, wetlands areas, geologic features such as rock types and their distribution, volcanic activity, ocean wave heights and wind speed. STS-68 will fly over the same sites that STS-59 observed so that scientists will be able to study seasonal changes that may have occurred in those areas between the missions.

An international team of 49 science investigators and three associates will conduct the SIR-C/X-SAR experiments. Thirteen nations are represented: Australia, Austria, Brazil, Canada, China, the United Kingdom, France, Germany, Italy, Japan, Mexico, Saudi Arabia and the United States.

The MAPS experiment will measure the global distribution of carbon monoxide in the troposphere, or lower atmosphere. Measurements of carbon monoxide, an important element in several chemical cycles, provide scientists with indications of how well the atmosphere can cleanse itself of "greenhouse gases," chemicals that can increase the atmosphere's temperature.

STS-68 will see the continuation of NASA's Get Away Special (GAS) experiments program. The project gives a person or organization a chance to perform experiments in space on a Shuttle mission. Two universities, North Carolina A&T State University and University of Alabama in Huntsville, and the Swedish Space Corp., Söna, Sweden, will have small self-contained payloads flying during the STS-68 mission. Other GAS hardware in Endeavour's payload bay will carry 500,000 commemorative stamps for the U.S. Postal Service in recognition of the 25th anniversary of the Apollo 11 Moon landing.

Other payloads aboard Endeavour include the Biological Research in Canister (BRIC) which will fly for the first time, and the Military Applications of Ship Tracks (MAST) which will be making its second flight. BRIC experiments, sponsored by NASA's Office of Life and Microgravity Sciences and Applications, are designed to examine the effects of microgravity on a wide range of physiological processes in higher order plants and arthropod animals (e.g., insects, spiders, centipedes, crustaceans). MAST is an experiment sponsored by the Office of Naval Research (ONR) and is part of a five-year research program developed by ONR to examine the effects of ships on the marine environment.

The Commercial Protein Crystal Growth (CPCG) experiment, the Chromosome and Plant Cell Division in Space Experiment (CHROMEX) and the Cosmic Radiation Effects and Activation Monitor (CREAM) experiment also will be carried aboard Endeavour.

Shuttle Mission STS-68 will be the 7th flight of Endeavour and the 64th flight of the Space Shuttle System.

- end -

## **MEDIA SERVICES INFORMATION**

### **NASA Television Transmission**

NASA Television is available through Spacenet-2, Transponder 5, located at 69 degrees west longitude with horizontal polarization. Frequency is 3880.0 MHz, audio is 6.8 MHz.

The schedule for television transmissions from the Shuttle and for mission briefings will be available during the mission at Kennedy Space Center, Fla; Marshall Space Flight Center, Huntsville, Ala.; Dryden Flight Research Center, Edwards, Calif.; Johnson Space Center, Houston, and NASA Headquarters, Washington, D.C. The television schedule will be updated to reflect changes dictated by mission operations.

Television schedules also may be obtained by calling COMSTOR 713/483-5817. COMSTOR is a computer data base service requiring the use of a telephone modem. A voice report of the television schedule is updated daily at noon Eastern time.

### **Status Reports**

Status reports on countdown and mission progress, on-orbit activities and landing operations will be produced by the appropriate NASA newscenter.

### **Briefings**

A mission briefing schedule will be issued prior to launch. During the mission, status briefings by a flight director or mission operations representative and when appropriate, representatives from the payload team, will occur at least once per day. The updated NASA Television schedule will indicate when mission briefings are planned.

## **STS-68 Quick Look**

**Launch Date/Site:** August 18, 1994/KSC Pad 39A  
**Launch Time:** 6:54 a.m. EDT  
**Orbiter:** Endeavour (OV-105) - 7th Flight  
**Orbit/Inclination:** 120 nautical miles/57 degrees  
**Mission Duration:** 10 days, 4 hours, 40 minutes  
**Landing Time/Date:** 11:34 a.m. EDT Aug. 28, 1994  
**Primary Landing Site:** Kennedy Space Center, Fla.  
**Abort Landing Sites:** Return to Launch Site - KSC, Fla.  
TransAtlantic Abort landing - Zaragoza, Spain;  
Moron, Spain; Ben Guerir, Morocco  
Abort Once Around - White Sands Space Harbor,  
N.M.

**STS-68 Crew:** Michael Baker, Commander (CDR)  
Terrence Wilcutt, Pilot (PLT)  
Thomas Jones, Payload Commander (MS4)  
Steven Smith, Mission Specialist 1 (MS1)  
Daniel Bursch, Mission Specialist 2 (MS2)  
Jeff Wisoff, Mission Specialist 3 (MS3)

Red shift: Baker, Wilcutt, Wisoff  
Blue shift: Bursch, Jones, Smith

**Cargo Bay Payloads:** Space Radar Laboratory-2 (SRL-2)  
Get Away Special canisters (GAS cans)

**Middeck Payloads:** Commercial Protein Crystal Growth (CPCG)  
Biological Research in Canisters (BRIC)  
Cosmic Radiation Effects and Activation Monitor  
(CREAM)  
Military Applications of Ship Tracks (MAST)

## **Detailed Test Objectives/Detailed Supplementary Objectives:**

DTO 251:	Entry Aerodynamic Control Surfaces Test
DTO 254:	Subsonic Aerodynamics Verification Objectives
DTO 301D:	Ascent Structural Capability Evaluation
DTO 305D:	Ascent Compartment Venting Evaluation
DTO 306D:	Descent Compartment Venting Evaluation
DTO 307D:	Entry Structural Capability Evaluation
DTO 312:	External Tank Thermal Protection System Performance
DTO 414:	Auxiliary Power Unit Shutdown Test
DTO 521:	Orbiter Drag Chute System Test
DTO 656:	PGSC Single Event Upset Monitoring
DTO 664:	Cabin Temperature Survey
DTO 700-8:	Global Positioning System Flight Test
DTO 805:	Crosswind Landing Performance
DSO 317:	Shuttle Humidity Condensate Collection/Evaluation
DSO 326:	Window Impact Observations
DSO 484:	Assessment of Circadian Shifting in Astronauts by Bright Light
DSO 487:	Immunological Assessment of Crewmembers
DSO 491:	Characterization of Microbial Transfer Among Crewmembers During Spaceflight
DSO 603B:	Orthostatic Function During Entry, Landing and Egress
DSO 604:	Visual-Vestibular Integration as a Function of Adaptation
DSO 605:	Postural Equilibrium Control During Landing/Egress
DSO 614:	The Effect of Prolonged Spaceflight on Head and Gaze Stability During Locomotion
DSO 621:	In-Flight Use of Florinef to Improve Orthostatic Intolerance Postflight
DSO 624:	Pre and Postflight Measurement of Cardiorespiratory Responses to Submaximal Exercise
DSO 626:	Cardiovascular and Cerebrovascular Responses to Standing Before and After Spaceflight
DSO 901:	Documentary Television
DSO 902:	Documentary Motion Picture Photography
DSO 903:	Documentary Still Photography

## SPACE SHUTTLE ABORT MODES

Space Shuttle launch abort philosophy aims toward safe and intact recovery of the flight crew, Orbiter and its payload. Abort modes include:

- \* **Abort-To-Orbit (ATO)** -- Partial loss of main engine thrust late enough to permit reaching a minimal 105-nautical mile orbit with orbital maneuvering system engines.

- \* **Abort-Once-Around (AOA)** -- Earlier main engine shutdown with the capability to allow one orbit around before landing at White Sands Space Harbor, N.M.

- \* **TransAtlantic Abort Landing (TAL)** -- Loss of one or more main engines midway through powered flight would force a landing at either Zaragoza, Spain; Moron, Spain; or Ben Guerir, Morocco.

- \* **Return-To-Launch-Site (RTL)** -- Early shutdown of one or more engines, and without enough energy to reach Zaragoza, would result in a pitch around and thrust back toward KSC until within gliding distance of the Shuttle Landing Facility.

STS-68 contingency landing sites are the Kennedy Space Center, White Sands, Zaragoza, Moron and Ben Guerir.

## **STS-68 Summary Timeline**

### **Flight Day One**

Ascent

OMS-2 burn (120 n.m. x 120 n.m.)

SRL-2 activation/operations

### **Blue Flight Days Two-Seven**

SRL-2 operations

- SIR-C/X-SAR Radar Imaging
- MAPS Carbon Monoxide Survey

### **Red Flight Days Two-Seven**

SRL-2 operations

- SIR-C/X-SAR Radar Imaging
- MAPS Carbon Monoxide Survey

### **Blue Flight Day Eight**

SRL-2 operations

- SSIR-C/X-SAR Interferometry
- MAPS Carbon Monoxide Survey

### **Red Flight Day Eight**

SRL-2 operations

- SIR-C/X-SAR Interferometry
- MAPS Carbon Monoxide Survey

### **Blue Flight Day Nine**

SRL-2 operations

- SIR-C/X-SAR Interferometry
- MAPS Carbon Monoxide Survey

### **Red Flight Day Nine**

Flight Control Systems Checkout

Reaction Control System Hot-Fire

SRL-2 deactivation

Cabin stow

### **Blue/Red Flight Day Ten**

Deorbit

Entry

Landing

### **STS-68 VEHICLE AND PAYLOAD WEIGHTS**

Vehicle/Payload	Pounds
Orbiter (Endeavour) empty and 3 SSMEs	173,669
Space Radar Lab-2	23,796
Get-Away Special Experiments	1,464
Biological Research in Canisters	20
Commercial Protein Crystal Growth	58
Chromosome and Plant Cell Division in Space	64
Cosmic Radiation Effects and Activation Monitor	39
Detailed Supplementary/Test Objectives	156
Total Vehicle at SRB Ignition	4,511,195
Orbiter Landing Weight	223,040

### **STS-68 Orbital Events Summary**

<b>EVENT</b>	<b>START TIME</b> (dd/hh:mm:ss)	<b>VELOCITY CHANGE</b> (feet per second)	<b>ORBIT</b> (n.m.)
OMS-2	00/00:33:00	164 fps	120 x 120
Deorbit	10/02:59:00	228 fps	N/A
Touchdown	10/03:59:00	N/A	N/A

## STS-68 CREW RESPONSIBILITIES

<b>TASK/PAYLOAD</b>	<b>PRIMARY</b>	<b>BACKUPS/OTHERS</b>
Shift CDR	Baker (red)	Bursch (blue)
Payload CDR	Jones	
SRL-2	Wisoff (red)	Jones (blue)
GAS Cans	Baker (red)	Smith (blue)

### Secondary Payloads:

CPCG	Smith	Wilcutt
CHROMEX	Smith	Wilcutt
CREAM	Wilcutt	Bursch
BRIC	Baker	Wilcutt
MAST	Bursch	Baker

### Detailed Supplementary/Test Objectives:

Medical DSOs	Bursch	Baker
DTO 251	Wilcutt	Baker
DTO 312	Jones	Smith
DTO 326	Wilcutt	Baker
DTO 414	Wilcutt	Bursch
DTO 521	Baker	Wilcutt
DTO 656	Wisoff	Jones
DTO 664	Smith	Wisoff
DTO 700-8	Bursch	Jones
DTO 805	Baker	Wilcutt

### Other:

Photography/TV	Wisoff	Smith
In-Flight Maintenance	Wisoff	Smith
EVA	Wisoff (EV1)	Smith (EV2), Wilcutt (IV)
Earth Observations	Wisoff	Wilcutt
Geography	Smith	Wilcutt
Oceanography	Bursch	Baker
Meteorology	Smith	Bursch
Medical	Bursch	Baker

## **SPACE RADAR LABORATORY-2 (SRL-2)**

### **SIR-C/X-SAR**

#### **Mission Objectives**

As part of NASA's Mission to Planet Earth, SIR-C/X-SAR is studying how our global environment is changing. From the unique vantage point of space, the radar system will observe, monitor and assess large-scale environmental processes. The spaceborne data, complemented by aircraft and ground studies, will give scientists highly detailed information that will help them distinguish natural environmental changes from those that are the result of human activity. NASA will distribute the Mission to Planet Earth data to the international scientific community so that this essential research is available worldwide to people who are trying to make informed decisions about protecting the environment.

SIR-C/X-SAR is also a part of the continuing efforts by DARA, the German Space Agency, and ASI, the Italian Space Agency, in the field of Earth observations.

#### **Why Radar?**

The unique feature of imaging radar is its ability to collect data over virtually any region at any time, regardless of weather or sunlight conditions. Some radar waves can penetrate clouds, and under certain conditions, can also see through vegetation, dry snow and extremely dry sand. In many cases, radar is the only way scientists can explore inaccessible regions of Earth's surface.

Radar is a lowercase acronym for "radio detection and ranging." A synthetic aperture radar transmits pulses of microwave energy toward Earth and measures the strength and time-delay of the energy that is scattered back to the antenna. In the case of SIR-C/X-SAR, the motion of the Shuttle creates, or synthesizes, an antenna opening, or aperture, that is much longer than the actual antenna hardware. A longer antenna produces images of finer resolution.

Conditions on the Earth's surface influence how much radar energy is reflected back to the antenna. An area with a variety of surface types, such as hills, trees and large rocks, will generally reflect more energy back to the radar than a less complex area such as a desert. The resulting radar image of the varied terrain will be brighter overall and have higher contrasts than the image of the simpler area. The three frequencies of SIR-C/X-SAR will enable scientists to view three different scales of features in the images.

## Results of STS-59

Flying aboard STS-59 in April 1994, SIR-C collected 65 hours of data during the 10-day mission, roughly corresponding to 26 million square miles (66 million square kilometers). All data were stored onboard the Shuttle using a new generation of high density, digital, rotary head tape recorders. The data filled 166 digital tape cartridges (similar to VCR tape cassettes). X-SAR data filled 25 of those tapes.

The mission returned 47 terabits of data ( $47 \times 10^{12}$  bits). Stated another way, each of the radars generates 45 million bits of data per second. When all the radars are operating, they produce 225 million bits of data per second, the equivalent of 45 simultaneously operating television stations. Using JPL's digital SAR processor and German-Italian X-SAR processors, the ground team processed the raw data into images.

High-priority SIR-C data were downlinked, processed, and released to the science team via the Internet within 24 hours of collection. The payload operations team processed the SIR-C data in survey mode and displayed it during the mission on NASA Television.

## Science

The STS-59 mission achieved 100 percent of the SIR-C/X-SAR science objectives. The SRL-1 team completed 850 data takes, 97% of those planned. The team acquired 99% of the "supersite" opportunities over highest priority targets. The 94 hours of radar imagery were obtained over 44 countries, covering 43.75 million square miles (70 million square kilometers). In addition to taking high-resolution data at all of the planned sites, the science team was able to adjust the mission timeline and observe events as they were happening on the ground. SIR-C/X-SAR took data of the severe flooding that inundated the mid-western United States and Thüringen, Germany, as well as three different views of tropical Cyclone Odille as it formed in the Pacific Ocean. Scientists also acquired a series of radar images over Canada documenting the annual spring thaw of snow, ice and soil.

Scientists use SIR-C/X-SAR data to study how our global environment is changing. The SIR-C/X-SAR radar data provides information about how many of Earth's complex systems—those processes that control the movement of land, water, air and life—work together to make this a livable planet. The science team particularly wants to study the amount of vegetation coverage, the extent of snow packs, wetlands areas, geologic features such as rock types and their distribution, volcanic activity, ocean wave heights and wind speed. STS-68 will fly over the same sites that STS-59 observed so that scientists will be able to study seasonal changes that may have occurred in those areas between the missions.

Data will be taken over more than 400 sites on Earth. Nineteen of the sites are "supersites," the highest priority targets and the focal point for many of the scientific investigators. There are 15 backup supersites. If problems should occur during the flight that would drastically reduce the team's ability to collect data, the supersite data will take precedence over other data acquisition.

During STS-59 the scientists who were working in the Payload Operations Control Center in Houston were in daily communication with the researchers who were part of the "ground truth" teams. The ground teams at several of the supersites made simultaneous measurements of vegetation, soil moisture, sea state, snow and weather during the mission. Aircraft and ships also collected data to ensure an accurate interpretation of the radar data taken from space. In addition, the astronauts recorded their personal observations of weather and environmental conditions in coordination with SIR-C/X-SAR operations.

### **Supersites**

The supersites represent different environments within each scientific discipline. They are areas where intensive field work will occur before, during and after the flight.

### **Ecology**

Supersites: Manaus, Brazil; Raco, Mich.; Duke Forest, N.C.

Ecologists study life on Earth and how different species of animals and plants interact with one another and their local environment. SIR-C/X-SAR ecology investigations focus on mapping wetlands, deforestation and flooding under forest canopies over the tropical forests of the Amazon basin in South America and over the temperate forests of North America and Central Europe. Scientists also are studying wetlands and are using the data to validate computer models to determine the type and density of vegetation and to study seasonal thaws. The science team will use the images to study land use, including the volume, types and extent of vegetation and the effects of fires, floods and clear-cutting.

Using early-release data, science team members have already generated both tree classification and vegetation biomass maps of the Raco, Michigan site and a freeze/thaw map over the Prince Albert, Saskatchewan backup supersite. A map of flooding near Manaus, Brazil also has been produced as a step toward improving models and our understanding of flooding and wetlands under dense forest canopies.

SIR-C/X-SAR's three radar frequencies interact with the vegetation in different ways, providing views of different parts of the forest. The shortest wavelength (X-band), reflects from the leaves of trees. C-band microwaves reflect from twigs and branches, and L-band wavelengths reflect from the

trunks of trees. These data give scientists a clearer picture of the conditions on the ground.

The science team will study seasonal changes in the forest by comparing data from the two SIR-C/X-SAR flights. For example, data from two previous imaging radar missions showed a decrease in forests along the Mississippi River between 1978 and 1981. Deforestation threatens both temperate and tropical forests around the world. SIR-C/X-SAR data and ground data will be used to understand the impact of the loss of forests on local populations of plants and animals. By studying the short-term and long-term changes in forests, scientists can determine what effects changing environmental conditions and land uses have on the forests and, in turn, on global climate change.

### **Hydrology**

Supersites: Chickasha, Oklahoma; Otztal, Austria; Bebedouro, Brazil; Montespertoli, Italy

SIR-C/X-SAR hydrology investigations are focused on Brazil, Austria, Italy and Oklahoma, where the radar data will be used to determine soil moisture patterns. These studies will help scientists develop ways to estimate soil moisture and evaporation rates over large areas, which could ultimately be incorporated into computer models to help predict a region's water cycle.

Another significant part of hydrology centers on snow cover. Using data from STS-59, investigators generated a snow and ice classification map over the Otztal, Austria, supersite and a snow-wetness map of the Mammoth Mountain, Calif., backup supersite. Spring snow melt often determines the annual runoff cycle and the resulting water supply, ground water and reservoir replenishment rates. For many areas, long-term or ground-based snow cover data do not exist, and radar data is the only efficient way to collect this information.

SIR-C/X-SAR acquired snow cover data over Mammoth Lakes, Calif., the Austrian Alps and northwest China. The shorter wavelength X-band data are useful in determining snow type, while the longer wavelengths of L-band and C-band help estimate snow thickness. These data might help communities determine how much water will be available for human and agriculture use. In August, this investigation's emphasis will shift to the Patagonian district in southern Chile, which contains the largest glaciers and ice fields in South America.

### **Oceanography**

Supersites: The Gulf Stream (mid-Atlantic region); eastern North Atlantic Ocean; Southern Ocean

Oceanographers study how waves move through the ocean and how the air and sea interact. The ocean is a reservoir for heat and energy, and the air-sea interaction moves this heat and energy around the globe regulating the Earth's climate. The Gulf Stream off the eastern coast of North America is a major ocean current that transports heat from the equator toward the poles.

The relatively low altitude of the Shuttle is particularly advantageous for oceanography investigations since the SIR-C/X-SAR radars are more sensitive to ocean features than satellites in higher orbits. Oceanographers are using data from SIR-C/X-SAR to study surface and internal waves and the interactions of waves and current. In addition, an associated experiment provided by the Applied Physics Laboratory of the Johns Hopkins University, Baltimore, Md., collected extensive information on wave energy over the Southern Ocean. These data will help scientists study how the ocean moderates Earth's climate.

## **Geology**

Supersites: Galapagos Islands; Sahara Desert; Death Valley, Calif.; Andes Mountains, Chile

Geologists study the present surface of the Earth. By observing older rocks they can determine how an area came to be and what it may have looked like in the past. Scientists are using SIR-C/X-SAR data to map geologic structures and variations in rock types over large areas, as well as areas of volcanic activity and erosion.

The longer L-band radar wavelength is particularly useful for looking beneath surfaces. SIR-C/X-SAR obtained penetration data of the Sahara desert that show stream channels and a larger river valley beneath an extensive sand sheet. On the ground and in photographs, this big valley and the channels in it are entirely covered by windblown sand. SIR-A observed some of these channels in 1981. Scientists hypothesize that an ancient westward-flowing river carved the large valley, tens of millions of years before the Nile River existed. The Nile flows north about 200 miles (300 kilometers) east of the area observed by the radar.

The existence of hidden river channels indicates that portions of the Sahara have undergone significant climate change and have evolved from an area of flowing streams to what is now an arid desert. SIR-C/X-SAR also is studying other geologic features that record past climate changes.

In areas of Death Valley, Calif., western China and the Patagonia region of the southern Andes, the radar imaged alluvial fans. Alluvial fans are gravel deposits that erode and wash down from the mountains. They are found throughout the semi-arid deserts of the world in areas where there is a significant amount of tectonic activity and erosion. The gravel builds up at the base of the mountains during periods of overall wetter climate. The

radar is sensitive to these rocky and rough surfaces, allowing scientists to study an area's climatic and geologic history and the relative age of surfaces. As an area ages, it is exposed to weathering. This changes its roughness characteristics. Studying past climate changes will give scientists a base from which to monitor and predict future climate changes.

During STS-59, SIR-C/X-SAR acquired radar images of several volcanoes, including Mount Pinatubo in the Philippines and the volcanoes of the Galapagos Islands. These radar images are helping scientists identify the different types of lava flows and their ages and assess environmental risks posed by the volcanoes. A key objective of STS-68 will be to obtain a second image of Mount Pinatubo during the summer monsoon season, when new mudflows are likely to occur, and to evaluate whatever short-term changes may have taken place.

### **Calibration**

Supersites: Flevoland, The Netherlands; Kerang, Australia; Oberpfaffenhofen, Germany; Western Pacific Ocean

The ground teams placed calibration devices, called corner reflectors, and transponders in southern Germany, the Netherlands, Australia and Death Valley, Calif., to measure the amount of radar energy obtained on the ground during the flight. The teams are calibrating the radar data and applying what they learn to the image processing and scientific interpretation of the images.

### **Rain Experiment**

Two SIR-C/X-SAR experiments imaged rain over the Western Pacific Ocean, an area scientists call the "rainiest place on Earth." Rain can change conditions on the surface and thus change the radar image. At the shorter wavelengths of X-band and C-band, rain may reduce the strength of the radar or scatter the signals significantly.

The rain experiments offer a unique challenge to the operation of the radar during flight. All the other experiments can be reasonably tied to a specific area, while the rain experiments only require that a "deep" rainstorm be in progress. Weather targets are transitory in both space and time and cannot be scheduled, so finding a good target of opportunity is a gamble. Scientists chose the western Pacific because there is a high probability that it will be raining there when the Shuttle passes over it.

### **Interferometry: A new SIR-C/X-SAR Experiment**

One of the bonuses of flying SIR-C/X-SAR for a second time is the opportunity to demonstrate a different data-gathering method from the Shuttle platform, called interferometry. Scientists will conduct the experiment during the last three days of the flight using repeated passes of

SIR-C/X-SAR over the same areas on the Earth. By comparing data from two repeated passes, investigators hope to generate digital elevation models (topography) of the Earth's surface. Once topography is determined, a third interferometric pass can be used to determine what, if any, topographic change has occurred in the intervening time between radar passes.

The focus of these experiments is to improve our understanding of natural hazards such as flooding, subsidence, mudflows, earthquakes and volcanic eruptions. For example, the topography of mountain glaciers is important because it directly reflects ice-flow dynamics and is closely linked to global climate and sea level change. Monitoring mountain glaciers on a global, long-term basis could give scientists important information on the rate of global warming. In addition, the use of topographic data may help reduce the risk of natural disasters by monitoring volcanoes, flooding and earthquake-prone faults.

### **Spaceborne Imaging Radar C/X-Band Synthetic Aperture Radar (SIR-C/X-SAR)**

SIR-C/X-SAR is a sophisticated set of radars that fills nearly all of Endeavour's cargo bay. SIR-C, built by the Jet Propulsion Laboratory (JPL) Pasadena, Calif., and the Ball Communications Systems Division, is a two-frequency radar including L-band (9-inch, or 23-cm, wavelength) and C-band (2.4-inch, or 6-cm wavelength). SIR-C is the first spaceborne radar with the ability to transmit and receive horizontally and vertically polarized waves at both frequencies. The multi-frequency, multi-polarization capability creates a new and more powerful tool for studying the world. A good way to understand this is to think of visual images: Just as color pictures have more information about a subject than black and white pictures, multi-frequency, multi-polarization radar images contain more information about the surface than single frequency, single polarization radar images.

The SIR-C antenna is the most massive piece of flight hardware ever built at JPL. Its mass is 16,100 pounds (7,300 kg) and it measures 39.4 feet by 13.1 feet (12 meters by 4 meters). The instrument comprises several subsystems: the antenna array, the transmitter, the receivers, the data-handling subsystem and the ground processor. The antenna consists of three leaves, and each is divided into four subpanels.

Hundreds of small transmitters embedded in the surface of the antenna form the radar beam. By adjusting the energy from these transmitters, the payload operations team can point the beam electronically, without moving the antenna. This feature, combined with the roll and yaw maneuvers of the Shuttle, will allow the team to acquire images from 15-to 55- degree angles of incidence.

Advances in radar technology will allow SIR-C to acquire simultaneous images at L-band and C-band frequencies at multiple polarizations.

Polarization describes how the radar wave travels in space. For example, for HH-polarized data, the antenna transmits energy in the horizontal plane and receives the backscattered radiation in the horizontal plane. For HV polarization, the wave is transmitted horizontally, but is received in the vertical plane. The interaction between the transmitted waves and the Earth's surface determines the polarization of the waves received by the antenna.

Multi-polarization data contain more specific information about surface conditions than single polarization data. Multi-polarization data are particularly useful to scientists studying vegetation because the data allow them to see different types of crops and to measure the volume of trees contained under the canopy of a forest. SIR-C can acquire data with HH, VV, HV, and VH polarizations.

X-SAR was built by the Dornier and Alenia Spazio companies for the German Space Agency, Deutsche Agentur fuer Raumfahrtangelegenheiten (DARA), and the Italian Space Agency, Agenzia Spaziale Italiana (ASI), with the Deutsche Forschungsanstalt für Luft- und Raumfahrt (DLR) as a major partner. It is a single-polarization radar operating at X-band (1-inch, or 3-centimeter wavelength).

X-SAR uses a finely tuned slotted waveguide antenna to produce a pencil-thin beam of energy. The X-SAR antenna rests on a supporting structure that is tilted mechanically to align the X-band beam with the L-band and C-band beams. X-SAR will provide VV polarization images.

The payload team can operate SIR-C and X-SAR independently or together. When combined into a three-frequency, multi-polarization instrument, SIR-C/X-SAR becomes the most powerful civilian radar ever flown in space. The width of the ground swath varies from 9 to 56 miles (15 to 90 kilometers), depending on the orientation of the antenna beams. The resolution of the radars varies from 33 to 656 feet (10 to 200 meters).

### **Previous Radar Missions**

Since the late 1970s a variety of NASA satellite missions have used imaging radar to study Earth and our planetary neighbors. Perhaps the most familiar example of NASA's success using imaging radar is the Magellan mission to Venus. Magellan's radar pierced the dense clouds covering Venus to map the entire surface of the planet, revealing a world hidden to humans until the late 20th century.

SIR-C is the latest in a series of Earth observing imaging radar missions that began in June 1978 with the launch of Seasat SAR and continued with SIR-A in November 1981 and with SIR-B in October 1984. Both the SIR-A and SIR-B sensors built upon the Seasat SAR, and all three could transmit and receive horizontally polarized radiation at L-band frequency.

The major difference between the Seasat and SIR-A sensors was the orientation of the radar's antenna with respect to Earth's surface. Microwave radiation transmitted by Seasat struck the surface at a fixed angle of approximately 23 degrees from the local zenith direction. SIR-A viewed the surface at a fixed 40-degree angle.

SIR-B improved upon both those missions because its antenna could be mechanically tilted. This allowed SIR-B to obtain multiple radar images of a given target at different angles during successive Shuttle orbits.

The X-SAR antenna is a follow-on to Germany's Microwave Remote Sensing Experiment (MRSE), which flew aboard the first Shuttle Spacelab mission in 1983.

These early missions had a tremendous impact on the international remote sensing community when SIR-A discovered ancient river beds hidden beneath the sands of the Sahara, and SIR-B data led explorers to the Lost City of Ubar in Oman.

#### **Data Acquisition Plans for STS-68**

Portions of the SIR-C/X-SAR data will be downlinked to the ground in near-real time through NASA's Tracking and Data Relay Satellite System (TDRSS). However, only one channel of data can be downlinked or played back at a time. This is not a problem for X-SAR since it only has one channel of data. SIR-C has up to four channels of data, and each channel must be played back separately. The payload teams will process the data in images using digital SAR processors in Pasadena, Calif., Oberpfaffenhofen, Germany, and Matera, Italy.

Historically, processing SAR data has required a great deal of computer time on special-purpose computer systems. SIR-C/X-SAR scientists will benefit, however, from rapid advances in computer technology that make it possible to process the images with a standard parallel supercomputer. Yet even with these advances, it will still take five months to produce survey images from the large volume of data acquired. Detailed processing will take another nine months. Italy, Germany and the United States will exchange data to meet the needs of the science investigators.

NASA, DARA and ASI will attempt to release some radar images to the press during the Shuttle flight. JPL will process SIR-C images and send them over the Internet to the Johnson Space Center, where the image will be released on NASA Television. JPL also will release hard-copy prints simultaneously to the wire services. In Germany, DLR will process X-SAR imagery. In addition, X-SAR "quick look" data will be available for release over NASA Television.

#### **Science Team**

An international team of 49 science investigators and three associates will conduct the SIR-C/X-SAR experiments, representing 13 nations: Australia, Austria, Brazil, Canada, China, England, France, Germany, Italy, Japan, Mexico, Saudi Arabia and the United States.

Dr. Diane Evans of JPL is the U.S. project scientist. Dr. Herwig Ottl of DLR is the German project scientist and Prof. Mario Calamia of the University of Florence is the Italian project scientist. Dr. Miriam Baltuck of NASA's Office of Mission to Planet Earth is the program scientist.

## **Management**

JPL manages the SIR-C mission for NASA's Office of Mission to Planet Earth, Washington, D.C. Michael Sander is the JPL project manager. X-SAR is managed by the Joint Project Office (JPO) located near Bonn, Germany. Rolf Werninghaus of DARA is the project manager and Dr. Paolo Ammendola of ASI is the deputy project manager. James McGuire of the Office of Life and Microgravity Sciences and Applications, Washington, D.C., is the SRL program manager. Richard Monson of the Office of Mission to Planet Earth is the SIR-C program manager.

## **MEASUREMENT OF AIR POLLUTION FROM SATELLITES (MAPS)**

The MAPS experiment measures the global distribution of carbon monoxide—an important indicator of the atmosphere's ability to cleanse itself of greenhouse gases and pollutants—in the lower atmosphere (2 to 10 miles above the surface). Covering the Earth between 57 degrees North latitude and 57 degrees South latitude, the MAPS measurements provide the only near-global database of lower-atmosphere carbon monoxide values available to scientists.

Preliminary results from the April 1994 MAPS flight aboard STS-59 showed low carbon monoxide concentrations in the Southern Hemisphere (very clean air) with a gradual increase, moving northward, in carbon monoxide levels. The highest levels of carbon monoxide were present north of the 40 degree latitude band in the Northern Hemisphere. The MAPS measurements will be correlated with ground- and aircraft-based carbon monoxide measurements, astronaut observations and photography, and meteorological data analyses and satellite images.

MAPS' unique measurements of carbon monoxide, a gas produced by the burning of gasoline and other carbon-based fuels, provide scientists with indications of how well the atmosphere can cleanse itself of these pollutants. How far pollutants such as carbon monoxide are transported from their source regions and the size of the source regions are two other invaluable pieces of information provided by the MAPS measurements.

Because MAPS is being flown twice this year, scientists will be able to examine seasonal differences in the distribution of carbon monoxide. This will be especially valuable to scientists studying the transportation of industrial pollutants in the Northern Hemisphere and biomass burning in the tropics and Southern Hemisphere.

The STS-68 flight will occur during the Southern Hemisphere's dry season (June-October), when the maximum amount of biomass burning, such as clearing forests for agriculture uses, occurs. The dry season carbon monoxide levels from this flight will be compared to data from the wet season (April 1994) flight. The MAPS measurements also will be compared to data from previous dry-season MAPS flights (November 1981 and October 1984).

### **Why do we measure carbon monoxide?**

World-wide increases in human technological and agricultural activity are causing increasing amounts of carbon monoxide to be released into the atmosphere. Carbon monoxide, a colorless and odorless gas, is produced by the burning of carbon-based fuels and by the burning of forests and grasslands.

Once released into the atmosphere, carbon monoxide can be transported over long distances, eventually converting to carbon dioxide by reacting with a chemical called the hydroxyl radical (chemical symbol: OH). The OH radical is a key participant in the destruction and removal of greenhouse gases such as methane. Methane also is important in the chemical cycle of stratospheric ozone.

As the amount of carbon monoxide in the atmosphere increases, its reactions with the OH radical increase accordingly. These reactions may leave less OH available to break down and remove greenhouse gases, chemicals that can trap heat near the Earth's surface, increasing atmospheric temperatures. Therefore, increases in carbon monoxide levels may cause subsequent decreases in OH levels, which can have long-term consequences on stratospheric ozone and the levels of various greenhouse gases, potentially influencing the Earth's climate.

### **Data Collection and Processing**

The primary goal of the MAPS experiment is to measure the distribution of carbon monoxide in the atmosphere between the altitudes of 2 to 10 miles (4 to 15 kilometers). The MAPS measurements will be stored on a tape recorder aboard the instrument and also will be transmitted to the ground in real-time through the Space Shuttle telemetry system. The real-time data transmissions will be processed at the Payload Operations Control Center to produce "quick look" maps of the measured carbon monoxide distribution. The "quick look" maps, along with real-time observations by the astronaut crew, will be used to determine areas of special interest, such as large areas of biomass burning.

An infrared camera attached to the MAPS instrument will take pictures of each region of the Earth being measured during the first half of the flight. The astronaut crew also will keep watch for any signs of industrial pollution (smoke stacks, gas flares from oil fields, etc.) and for smoke and fires caused by biomass burning. Real-time observations by the astronaut crew and the analysis of astronaut and MAPS instrument photographs, will play a crucial role in understanding the measurements from the MAPS experiment.

Following the flight, the data recorded aboard the instrument and the data transmitted to the ground in real-time will be merged, then processed using more sophisticated techniques than the preliminary ("quick look") MAPS data. In addition, the MAPS measurements will be correlated with a global network of intercalibrated ground- and aircraft-based measurements. To ensure the accuracy of the ground and aircraft measurements, all the ground sites will be using the same four gas cylinders to calibrate their instruments. This ensures that all the ground sites have the same calibration standard (that they are 'intercalibrated') and allows for the intercomparison of carbon monoxide data measured by dozens of different instruments around the world.

The 25 ground sites include locations in the United States, South Africa, Russia, Germany, Bermuda, Ireland, Hong Kong, Australia, and New Zealand. The aircraft underflights of the MAPS instrument include the NASA DC-8, and aircraft from INPE, Brazil; CSIRO, Australia; the University of Maryland; and the National Oceanic and Atmospheric Administration in Boulder, Colo.

### **Results From Previous Flights**

MAPS, the first Space Shuttle science payload, has flown three times: in November 1981 (STS-2), October 1984 (STS-41G) and April 1994 (STS-59). The 1981 flight proved surprising because the greatest concentrations of tropospheric carbon monoxide were found in the Earth's tropical regions rather than in the industrialized Northern Hemisphere as had been expected. The 1981 flight also showed that carbon monoxide concentrations vary greatly from region to region.

The October 1984 flight confirmed the November 1981 finding that the burning of forests in South America and grasslands in Africa is a significant source of global tropospheric carbon monoxide during the Southern Hemisphere spring (dry season).

Preliminary results from the April 1994 flight show low carbon monoxide concentrations in the Southern Hemisphere (very clean air) and a gradual increase in carbon monoxide levels from the Southern Hemisphere to the Northern Hemisphere. The highest levels of carbon monoxide measured by MAPS were present north of the 40 degree latitude band in the Northern Hemisphere.

Because the second 1994 flight of MAPS occurs during the burning season in South America and Africa, scientists will be able to study the source regions of carbon monoxide as well as its transport from the source regions. Real-time data analysis by the MAPS operations team and observations by the astronaut crew will help the scientists on the ground evaluate the data and determine those regions where more detailed measurements should be made by the MAPS instrument.

Because there will be two flights in the same year, scientists also will be able to study the changes in carbon monoxide distributions from the Southern Hemisphere wet season (April) to the dry season (August), when biomass burning is at a maximum.

Scientists also will be able to examine the seasonal effects near and downwind from the industrial source regions of the Northern Hemisphere. This ability to study global seasonal differences in tropospheric carbon monoxide levels is available only through the unique measurements provided by the MAPS instrument.

## **Mission Information**

Information on the MAPS experiment for both the SRL-1 and SRL-2 flights is available through Internet 24 hours a day. The information is available via DOS, MAC, and UNIX platforms. This information will be updated weekly prior to the SRL-2 launch with updates during the mission as time allows.

The information can be accessed through NCSA Mosaic (an Internet information browser and World Wide Web client). For information on obtaining Mosaic software or help using it please send electronic mail to:

`mosaic@ncsa.uiuc.edu`

For those who already have Mosaic, to access the Mosaic MAPS home page directly, click on the File button in the header at the top of the Mosaic home page; click on Open; type in URL to open:  
`http://stormy.larc.nasa.gov/press.html`; click on Open.

For more information on the MAPS home page please contact:

Scott Nolf: `s.r.nolf@larc.nasa.gov`

## **The MAPS Instrument**

The MAPS flight hardware consists of an optical box, an electronics box, a tape recorder and a camera, all mounted to a single baseplate. This assembly is mounted to a Multi-Purpose Experiment Support Structure near the forward end of the cargo bay. The instrument is about 36 inches long, 30 inches wide, and 23 inches high. It weighs 203 pounds and consumes about 125 watts of electrical power.

The Program Manager is Louis Caudill, and Dr. Robert J. McNeal is the Program Scientist, both at NASA Headquarters, Washington, D.C. The MAPS Principal Investigator is Dr. Henry G. Reichle, Jr., and the Project Manager is John Fedors, both at NASA Langley Research Center in Hampton, Va.

## **GET AWAY SPECIALS**

Two universities and a foreign country have small self-contained payloads flying on this mission. These customers are taking advantage of NASA's unique Get Away Special (GAS) program. GAS, managed by the Goddard Space Flight Center (GSFC), Greenbelt, Md., provides an opportunity for anyone in the world to access space.

The GAS program presents an excellent educational tool for students. Individuals and organizations are able to send scientific research and development experiments into space aboard the Space Shuttle. So far, more than a hundred GAS payloads have flown on the Shuttle. Customers flying payloads on this mission include: G-316, North Carolina A&T University; G-503, University of Alabama in Huntsville; G-541, Swedish Space Corp. Following is a brief description of each.

### **G-316**

**Customer: North Carolina A&T State University, Greensboro, NC**

**Customer: Dr. Stuart Ahrens**

**NASA Technical Manager: Charlie Knapp**

This payload contains two experiments designed to take advantage of the microgravity environment of the orbiting Shuttle. The first is a biology experiment that will study the effects of microgravity on the survival, mating and development of the milkweed bug. The second is a chemistry experiment that will use the microgravity environment to improve the growth quality and size of a crystal of rochelle salt.

The entire payload weighs 100 pounds (45.36 kilograms) and fits in an airtight cylindrical canister which is mounted out in the payload bay of the orbiter. The payload is entirely self-contained and automated except for two relays that are controlled from the orbiter by the crew. Approximately half of the payload weight is due to batteries needed to control the experiments and keep the payload warm.

The payload was conceived, designed and fabricated entirely by students in the university's Student Space Shuttle Program (SSSP). The SSSP owes its beginning to the late North Carolina A&T graduate and astronaut, Dr. Ronald E. McNair. More than 100 students representing 12 different majors have participated in the SSSP. The SSSP has received support in excess of \$500,000 from more than 25 outside organizations, including Fortune 500 corporations. This support has been in the form of funds, consultation and payload parts.

In addition to the primary goal of conceiving, designing and fabricating the payload, the SSSP has a number of secondary goals that are very important. These secondary goals are: to enhance the classroom experience by placing students in a real world project; to develop in students a strong sense of professionalism about their work; to have

students interface with the high technology of the Space Shuttle; and to motivate students to pursue Dr. McNair's dream.

When G-316 is launched aboard Endeavour in August, a number of tributes to Dr. McNair also will be on board. Attached to the outside of the payload's canister will be a large emblem in the university's colors. Included in the emblem will be the university's name and mascot and the inscription "Dr. Ron McNair, 1950-1986." Also in the orbiter's cabin will be two special 8x10 color photos, one of the Challenger crew and one of Dr. McNair.

### **G-503**

**Customer: University of Alabama in Huntsville, Huntsville, Ala.**

**Customer: Candance Townley**

**NASA Technical Manager: Charlie Knapp**

This payload is sponsored by the Students for the Exploration and Development of Space at the University of Alabama in Huntsville to promote hands-on experience for its members.

The primary objective of this payload is to successfully complete the following experiment: diatom (microscopic algae) growth and survivability in a cosmic radiation and microgravity environment; the mixing and curing of concrete; a study of microgravity influenced root growth; and a study of corrosive pitting in stainless steel. The secondary objective of these experiments is to provide students with a hands-on education of what is necessary to conduct scientific research in the space environment (funding, design, paperwork, manufacturing, testing, etc.).

**Experiment #1:** The Microgravity and Cosmic Radiation Effects on Diatoms (MCRED) is the first test of a concept for a bioregenerative (ability for organisms to regenerate) life support system to be used on space station and Lunar/Mars expeditions. The experiment is designed to grow a series of diatom cultures in an ambient environment in low-Earth orbit. The microgravity and cosmic radiation effects will be evaluated based on recorded cell populations. The data will generate growth curves for study and interpretation. An additional study of physical changes in the cell wall structure (silicon dioxide) will be performed that will provide information about changes in cell metabolism. The results will be compared against ground experiments operating simultaneously to determine the cause of any observed changes.

**Experiment #2:** The Concrete Curing In Microgravity (ConCIM) experiment is designed to give scientists and engineers valuable data about the feasibility of mixing and curing concrete in a microgravity environment. This data would be extremely valuable for future moon base applications. The concrete, cured for at least seven days in microgravity, will develop most of its ultimate chemical and physical properties. Once the experiment has been recovered, testing and material analysis will be performed to determine the chemical composition, the pore structure and strength of the

space concrete. Test results will be compared to data obtained from a ground-based control sample of concrete, mixed and cured under similar conditions to determine the effect of the gravitational differences.

**Experiment #3:** The Root Growth In Space (RGIS) experiment will study effects of microgravity on the early stages of germination of several seed types. The specific effects to be examined include production of gases during germination and the development and distribution of chemicals and hormones as they are affected by gravity.

**Experiment #4:** The Microgravity Corrosion Experiment (COMET) is designed to examine the effects of microgravity on the mutation and growth of pitting in metals. Pitting is an extremely localized corrosion phenomenon which initiates on exposed surfaces and results in holes in the metal. It is one of the most destructive and insidious forms of corrosion and usually occurs in metal systems that exhibit a passive layer. Its effects are particularly vicious because it is a localized and intense form of corrosion, and failures often occur with extreme suddenness. Also, unlike many types of corrosion, pitting is difficult to predict.

COMET will attempt to induce pitting in a stainless steel sample in order to study it in the absence of gravity and determine what forces drive this type of corrosion. This experiment has applications on Earth as well as in space for preventing pitting in corrosive material piping systems.

The first three experiments are from students at the University of Alabama in Huntsville while the fourth experiment is from students at the University of Alabama in Birmingham.

#### **G-541**

**Customer: Swedish Space Corp., Solna, Sweden**

**Customer: Kjell Anflo**

**NASA Technical Manager: Barbara Milner**

The purpose of this experiment is to study the breakdown of a planar solid/liquid interface during crystal growth. A sample of Germanium treated with Gallium will be processed during the flight.

The experiment is performed in a gradient furnace. In this furnace, which was developed for the previous G-330 flight, the growth rate can be controlled along the length of the crystal. The furnace is designed with electro-dynamic control of the temperature with a gradient moving along the sample.

First the sample is heated up, melted and a controlled temperature gradient of 20 degrees Celsius is established. It is important to keep a short part of the sample solid because this part acts as a monocrystal seed. Subsequently the absolute temperature is decreased but the temperature gradient is maintained. The rate of the solidification front is kept constant

at approximately 1 mm/sec. The dopant (an impurity added to a pure substance to produce a deliberate change) concentration along the sample is higher in the hot end. The interface will become unstable and will break down when the solidification front reaches the part of the sample where the dopant concentration increases.

The interface demarcations are expected to reveal the development of the size of the disturbances and the wavelengths during interface breakdown. The thermo-couples and spreading resistance measurements will give accurate data of temperature gradients and dopant concentration, respectively.

The payload consists of the following subsystems:

- \* Multi Zone furnace, ceramic tube with five heating elements and a cooler
- \* Sample cooling system, low pressure internal cooling system
- \* Mechanical structure
- \* Microprocessor-based system for control of the experiment, data handling and housekeeping
- \* Accelerometers
- \* Energy system, sealed lead batteries (1375 Wh)

#### **Other GAS hardware**

GAS hardware also is being used by the U.S. Postal Service to fly 500,000 commemorative stamps in recognition of the 25th anniversary of the Apollo 11 Moon Landing. The stamp that is being flown is a \$9.95 Express Mail stamp. Artwork for the stamp was created by the father and son team of Paul and Chris Calle, experienced stamp designers and participants in the NASA Art Program.

The new stamp shows two astronauts on the moon's surface with the Apollo landing module. The Express Mail stamp will be sold individually and in panes of 20 stamps.

## **SECONDARY PAYLOADS**

### **COMMERCIAL PROTEIN CRYSTAL GROWTH (CPCG)**

The Commercial Protein Crystal Growth (CPCG) experiment has several objectives. One objective is to grow and retrieve highly structured protein crystals of sufficient size and quality to analyze the molecular structures of various proteins. Another objective is to obtain information on the dynamics of protein crystallization, allowing scientists to determine the parameters necessary to optimize scientific methods for producing large, high quality, well-ordered crystals.

The CPCG experiment will be flown in what is known as a Block I configuration for STS-68. This configuration includes the utilization of one Commercial Refrigerator/Incubator Module (CRIM) to maintain a specific profile for three Vapor Diffusion Apparatus (VDA) trays. Each VDA tray contains 20 double-barrel syringes which empty into individually sealed sample chambers. Each syringe contains a protein solution in one barrel and a precipitant solution in the other barrel.

The 20 syringes are ganged together on each of the VDA trays so that all the syringes on one VDA tray are deployed by one crew operation. The liquids in the syringes are deployed and retracted several times to adequately mix the protein and precipitant solutions. The final liquid deployment from the syringes leaves the fluid drop hanging on the end of the syringe tip. This configuration mimics a typical "hanging drop" configuration that is widely used for ground-based crystallization processes driven by vapor diffusion.

The growth chamber surrounding the syringe tip contains a reservoir with a highly concentrated solution of precipitating agent. The crystallization process is driven by the difference in the vapor pressures of the hanging drop and the reservoir solution. Water vapor is transported from the hanging droplet of protein/precipitant solution to the reservoir solution of precipitating agent. Protein crystallization is initiated when the protein/precipitant concentrations within the hanging drop are altered by this vapor transport. When a unique protein/precipitant concentration for a particular sample is obtained in each of the growth chambers, crystallization occurs.

## **Biological Research in Canisters - BRIC-01**

STS-68 will fly the first in a new series of life sciences experiments titled, "Biological Research in Canisters (BRIC)." BRIC experiments, sponsored by NASA's Office of Life and Microgravity Sciences and Applications, are designed to examine the effects of microgravity on a wide range of physiological processes in higher order plants and arthropod animals (e.g., insects, spiders, centipedes, crustaceans). BRIC hardware consists of a small, self-contained, two-chambered aluminum container that requires no power. The first BRIC experiment (BRIC-01) will fly gypsy moth eggs to determine how microgravity affects the developing moth's diapause cycle. The diapause cycle is the period of time when the moth is in a dormant state and undergoing development. Previous spaceflights of gypsy moths have indicated that microgravity may shorten the diapause cycle which leads to the emergence of sterile gypsy moth larvae. Since the gypsy moth is among the most damaging insect pests of hardwood trees in the eastern United States, extensive ground-based research has been conducted to modify the gypsy moth's life cycle to create sterile moths. Results from NASA's BRIC-01 experiment could greatly enhance these research efforts. The investigator for this experiment, Dr. Dora K. Hayes, is a scientist with the U.S. Department of Agriculture in Beltsville, Md., in the Livestock Insects Laboratory.

## **CHROMEX-05**

STS-68 marks the fifth flight in the series of CHROMEX experiments designed to examine the effects of microgravity on a wide range of physiological processes in plants. CHROMEX experiments are flown in the Plant Growth Unit (PGU), an automated system that provides lighting, limited temperature control, and nutrients to support plant growth in the Shuttle middeck. Previous CHROMEX experiments (CHROMEX-03 and 04) indicate that plants grown in space may not produce seed embryos. The primary objective of CHROMEX-05 is to determine if plants grown in space are infertile due to microgravity or some other environmental factor. For this experiment, 13-day old Mouse-ear Cress (*Arabidopsis thaliana*) seedlings will be grown in space and will be compared to plants grown under similar conditions on the Earth. Results from this experiment will advance the field of space biology and will benefit the development of planned plant-based life support systems for future long duration space crews. Results may also benefit the nation's horticulture industry which produces plants under artificial conditions (e.g., aquaculture). The principal investigator for the primary experiment is Dr. Mary Musgrave, an associate professor in the department of Plant Pathology and Crop Physiology in the Louisiana Agricultural Experiments Station of the Louisiana State University Agricultural Center. The CHROMEX experiments are sponsored by NASA's Office of Life and Microgravity Sciences and Applications.

## **COSMIC RADIATION EFFECTS AND ACTIVATION MONITOR (CREAM)**

The Cosmic Radiation Effects and Activation Monitor (CREAM) experiment on STS-68 is designed to collect data on cosmic ray energy loss spectra, neutron fluxes and induced radioactivity. The data will be collected by active and passive monitors placed at specific locations throughout the orbiter's cabin.

The active monitor will obtain real-time spectral data while the passive monitors will obtain data during the entire mission to be analyzed after the flight. The flight hardware contains the active cosmic ray monitor, a passive sodium iodide detector and up to five passive detector packages. All hardware fits in one locker on Endeavour's middeck. Once in orbit, a crew member will be available at regular intervals to monitor the payload/experiment. CREAM is a Department of Defense payload and is flown under the direction of the DoD's Space Test Program.

## **MILITARY APPLICATIONS OF SHIP TRACKS (MAST)**

The Office of Naval Research (ONR) is sponsoring the Military Applications of Ship Tracks (MAST) experiment on STS-68. MAST, which flew for the first time on STS-65 in July 1994, is part of a five-year research program developed by ONR to examine the effects of ships on the marine environment. The Naval Postgraduate School, Monterey, Calif., will conduct the experiment at the Johnson Space Center during the mission. The objective of MAST is to determine how pollutants generated by ships modify the reflective properties of clouds. Ship tracks are observed in satellite imagery as long, narrow, curvilinear cloud features that have greater brightness than the surrounding clouds. The STS-68 crew will photograph ship tracks using handheld cameras. These high-resolution photographs will provide insight into the processes of ship track production on a global scale. MAST will help in understanding the effects of man-made aerosols on clouds and the resulting impact on the climate system. MAST is a Department of Defense payload and is being flown under the direction of the DoD Space Test Program.

## STS-68 CREW BIOGRAPHIES

**Michael (Mike) A. Baker**, 40, Capt., USN, will be Commander (CDR) of STS-68. Selected as an astronaut in 1985, Baker considers Lemoore, Calif., his hometown and will be making his third Shuttle flight.

Baker graduated from Lemoore Union High School in 1971 and received a bachelor's degree in aerospace engineering from the University of Texas in 1975.

Baker's first Shuttle flight was as pilot aboard Atlantis' STS-43 mission in August 1991, a mission that deployed the fifth NASA Tracking and Data Relay Satellite. His second flight was as pilot of STS-52 in October 1992, a mission that deployed the Italian Laser Geodynamic Satellite and operated the first United States Microgravity Payload.

Baker has logged more than 450 hours in space and more than 4,300 hours of flying time in 50 different types of aircraft.

**Terrence (Terry) W. Wilcutt**, 44, Major, USMC, will be Pilot (PLT) of STS-68. Selected as an astronaut in 1990, Wilcutt considers Russellville, Ky., his hometown and will be making his first Shuttle flight.

Wilcutt graduated from Southern High School, Louisville, Ky., in 1967 and received a bachelor's degree in math from Western Kentucky University in 1974.

After graduating from college, Wilcutt taught high school math for two years before joining the Marine Corps. Wilcutt earned his wings in 1978 and had initial training in the F-4 Phantom aircraft. He later attended the Naval Fighter Weapons School (Top Gun) and made two overseas deployments to Japan, Korea and the Philippines. In 1986 he attended the Naval Test Pilot School and graduated with distinction. He then served as a test pilot and project officer for the Strike Aircraft Test Directorate, Patuxent River, Md., until his selection by NASA.

Wilcutt has over 3,000 flight hours in more than 30 different types of aircraft.

**Thomas (Tom) D. Jones**, 39, Ph.D., will be Payload Commander and Mission Specialist 4 (MS4) on STS-68. Selected as an astronaut in 1990, Jones was born in Baltimore, Md., and will be making his second space flight.

Jones graduated from Kenwood Senior High School, Essex, Md., in 1973; received a bachelor's degree in basic sciences from the Air Force Academy in 1977; and received a doctorate in planetary science from the University of Arizona in Tucson in 1988.

Jones served as an Air Force officer for six years, flying strategic bombers at Carswell AFB, Texas, and accumulating more than 2,000 hours of jet experience. He resigned his commission in 1983 and began work on his doctorate as a graduate research assistant. Following graduation in 1988, he served as a program management engineer in the CIA's Office of Development and Engineering. In 1990, he joined Science Applications International Corp., as a senior scientist, working on advanced program planning for the Solar System Exploration Division at NASA Headquarters, Washington, D.C.

Jones' first flight was as a mission specialist on STS-59 in April 1994, the first flight of the Space Radar Lab. He has logged more than 269 hours in space.

**Steven (Steve) L. Smith**, 35, will be Mission Specialist 1 (MS1). Selected as an astronaut in 1992, he considers San Jose, Calif., his hometown and will be making his first space flight.

Smith graduated from Leland High School in San Jose in 1977; received a bachelor's degree in electrical engineering from Stanford University in 1981; received a master's degree in electrical engineering in 1982 from Stanford; and received a master's degree in business administration in 1987 from Stanford.

Smith worked for IBM in the Large Scale Integration Technology Group in San Jose from 1982-1985, working on the development of electron beam chemical and lithographic processes for semiconductors. After a leave to pursue graduate studies, Smith returned to IBM's Hardware and Systems Management Group in Santa Clara, Calif., as a product manager for voice and telephony products.

Smith joined NASA in 1989, serving in the Payload Operations Branch, Mission Operations Directorate, at the Johnson Space Center. He supported STS-37, STS-48, and STS-49 as a Payload Officer in Mission Control before his selection as an astronaut.

**Daniel (Dan) W. Bursch**, 37, CDR., USN, will be Mission Specialist 2 (MS2). Selected as an astronaut in 1990, Bursch considers Vestal, N.Y., his hometown and will be making his second space flight.

Bursch graduated from Vestal Senior High School in 1975; received a bachelor's degree in physics from the Naval Academy in 1979; and received a master's degree in engineering science from the Naval Postgraduate School in 1991.

Bursch's first Shuttle flight was as a mission specialist on STS-51 in September 1993, a mission that deployed the Advanced Communications

Technology Satellite and the Orbiting Retrievable Far and Extreme Ultraviolet Spectrometer/Shuttle Pallet Satellite.

Bursch has logged more than 236 hours in space and more than 2,100 hours flying time in over 35 different aircraft.

**Peter (Jeff) J.K. Wisoff**, 36, Ph.D., will be Mission Specialist 3 (MS3). Selected as an astronaut in 1990, Wisoff considers Norfolk, Va., his hometown and will be making his second space flight.

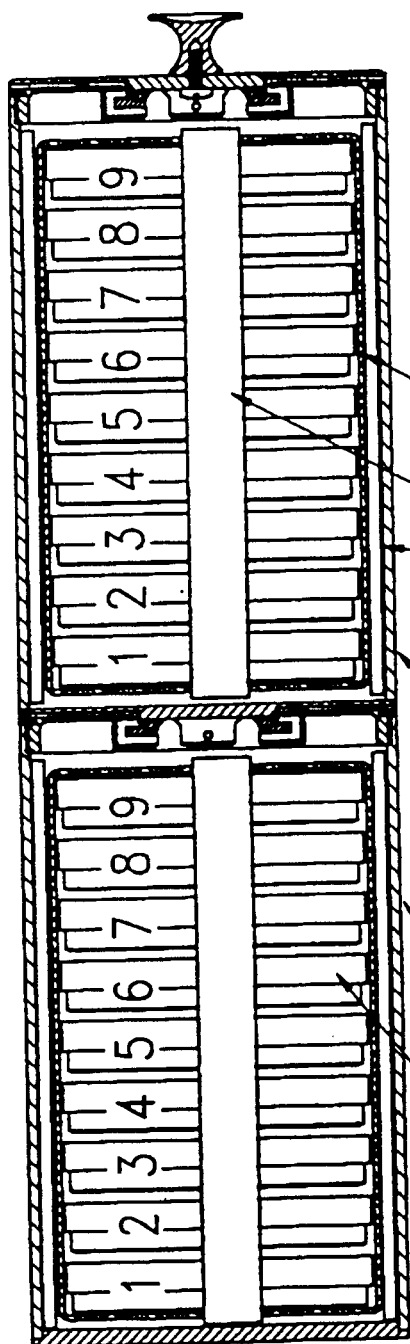
Wisoff graduated from Norfolk Academy in 1976; received a bachelor's degree in physics from the University of Virginia in 1980; received a master's degree in applied physics from Stanford University in 1982; and received a doctorate in applied physics from Stanford in 1986.

After completing his doctorate, Wisoff joined the Rice University faculty in the Electrical and Computer Engineering Department, researching the development of new vacuum ultraviolet and high intensity laser sources and the medical application of lasers to the reconstruction of damaged nerves.

His recent work includes collaboration with researchers at Rice University on developing new techniques for growing and evaluating semiconductor materials using lasers.

Wisoff's first flight was as a mission specialist on STS-57, a mission that retrieved the European Retrievable Carrier satellite and was the first flight of Spacehab. He has logged more than 239 hours in space.

SIDE VIEW (SECTION)



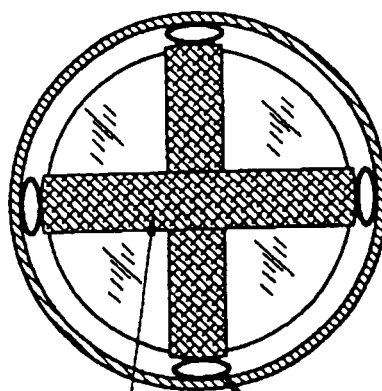
PETRI DISHES (18)

LOWER CANISTER

UPPER CANISTER

TEFLON TUBE

TOP VIEW (SECTION)



GORTEX STRAP

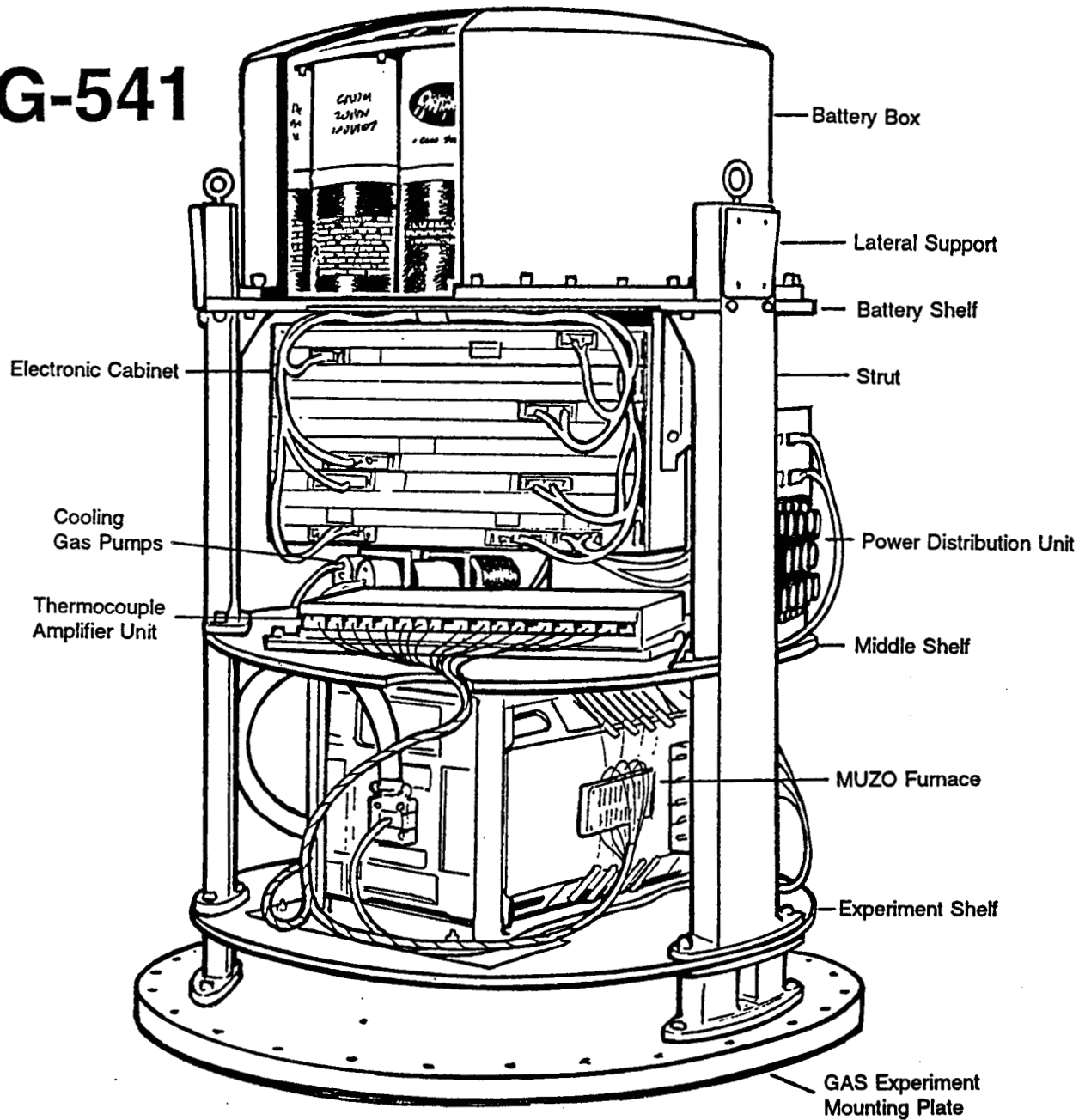
TEFLON TUBE

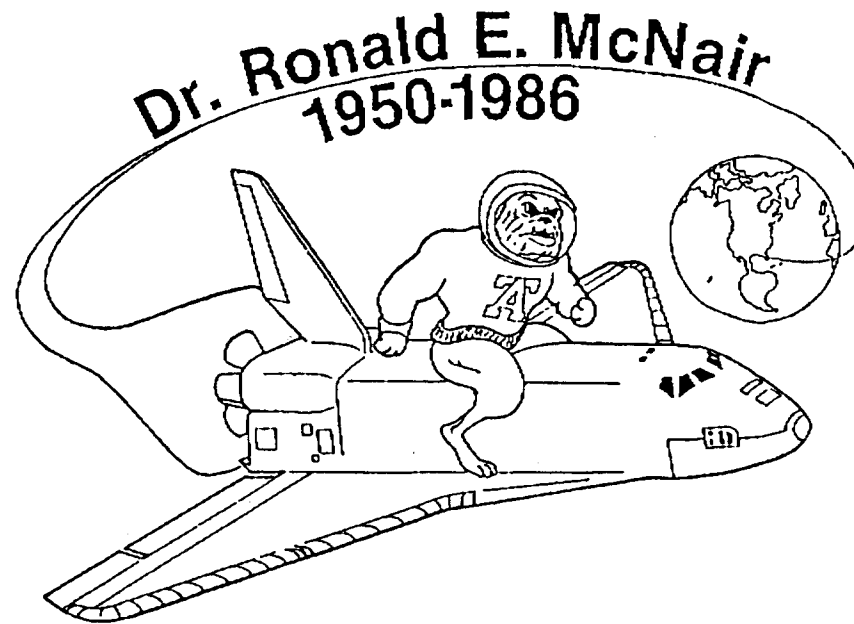
DISH CONTENTS

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|----|------------------|
| 1) | H <sub>2</sub> O |
| 2) | Moth             |
| 3) | Moth             |
| 4) | Moth             |
| 5) | H <sub>2</sub> O |
| 6) | Moth             |
| 7) | Moth             |
| 8) | H <sub>2</sub> O |
| 9) | LiOH             |

**BRIC-01**

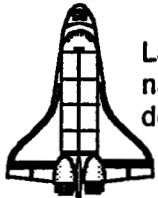
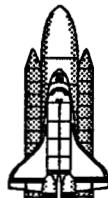
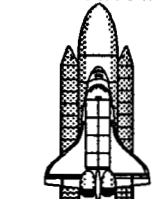

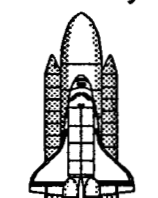

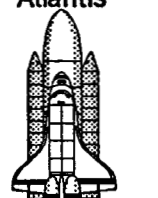

# G-541





NORTH CAROLINA  
& T  
STATE UNIVERSITY

# Upcoming Space Shuttle Flights

 <b>Columbia STS-65</b> 1994 Pad 39-A Launch targeted for July. Primary payload is the International Microgravity Laboratory-2. Inclination 28.45 degrees/185 st. miles. 13 days. Crew: Robert D. Cabana; James D. Halsell Jr.; Richard J. Hieb (PC); Leroy Chiao; Donald A. Thomas; Carl E. Walz; Chiaki Mukai. Landing: KSC * Lisa Malone	 <b>Endeavour STS-67</b> 1995 Pad 39-B Launch targeted for January. Payload is ASTRO-2. Crew: Stephen S. Oswald; William C. Gregory; Tamara E. Jernigan (PC); John M. Grunsfeld; Wendy B. Lawrence; Ronald A. Parise; Samuel T. Durrance. Inclination 28.45 degrees/218 st. miles. Duration 13 days, 14 hours. Landing: KSC * Bruce Buckingham
 <b>Endeavour STS-68</b> 1994 Pad 39-A Launch targeted for August. Payloads include Space Radar Laboratory-2 and MAPS-2. Inclination 57 degrees 138 st. miles. Nine days. Crew: Michael A. Baker; Terrence W. Wilcutt; Thomas D. Jones (PC); Steven L. Smith; Peter J. K. Wisoff; Daniel W. Bursch. Landing: KSC * Bruce Buckingham	 <b>Discovery STS-63</b> 1995 Pad 39-A Launch targeted for February. Payloads are SPACEHAB-3, Spartan-204, Concap-II, and CGP/ODERACS-2. Mir fly around. Inclination 51.60 degrees/195 st. miles. 8 days. Crew: James D. Wetherbee, Eileen M. Collins, C. Michael Foale, Janice Voss Ford, Bernard A. Harris, Vladimir Titov. Landing: KSC * George Diller
 <b>Discovery STS-64</b> 1994 Pad 39-B Launch targeted for September. Payloads include LIDAR-In-space Technology Experiment (LITE) and Spartan 201-02. Inclination 57 degrees/161 st. miles. Nine days. Crew: Richard N. Richards; L. Blaine Hammond Jr.; Carl J. Meade; Mark C. Lee; Susan J. Helms; Jerry M. Linenger. Landing: KSC * George Diller	 <b>Endeavour STS-69</b> 1995 Pad 39-B Launch targeted for May. Payloads are WSF-2, OAST, IEH-1, and GBA. Inclination 28.45 degrees/190 st. miles. Ten days. Crew: James S. Voss - no others assigned as of this date. Landing: KSC * Lisa Malone
 <b>Atlantis STS-66</b> 1994 Pad 39-A Launch targeted for October. Payloads include ATLAS-3, CRISTA-SPAS, SSBUV/A-3. Inclination 57 degrees/188 st. miles. 11 days. Crew: Donald R. McMonagle; Curtis L. Brown; Ellen Ochoa (PC); Scott E. Parazynski; Joseph R. Tanner; Jean-Francois Clervoy. Landing: KSC * Lisa Malone	 <b>Atlantis STS-71</b> 1995 Pad 39-A Launch targeted for May. First MIR docking/crew exchange. 5 NASA/2 Russians going up: Robert L. Gibson, Charles Precourt, Ellen Baker, Greg Harbaugh, Bonnie Dunbar, Anatoly Solovyev and Nikolai Budarin; 6 NASA/2 Russians coming back: same NASA crew as above and Norm Thagard, Vladimir Dezhurov and Gennadiy Strekalov. Inclination 51.6 degrees/195-237 st. miles. Nine days. Landing: KSC * Bruce Buckingham

**NOTES ON THIS SCHEDULE:** This is an unofficial Space Shuttle launch schedule covering the period from June 1994 through May 1995. Crew listing names commanders first, then pilots, then mission and payload specialists. This flight listing is based on April 1994 Mixed Fleet Manifest. This graph is prepared by the Kennedy Space Center Media Services Branch and is dated June 1, 1994. Abbreviations used include: \* = Public Affairs Commentator. PC = Payload Commander. Official launch dates are set at the Flight Readiness Review.

# SHUTTLE FLIGHTS AS OF JULY 1994

63 TOTAL FLIGHTS OF THE SHUTTLE SYSTEM -- 38 SINCE RETURN TO FLIGHT

<div>STS 51-L 01/28/86</div> <div>STS 51-A 10/30/85 - 11/06/85</div> <div>STS 51-F 07/29/85 - 08/06/85</div> <div>STS 51-B 04/29/85 - 05/06/85</div> <div>STS 41-G 10/05/84 - 10/13/84</div> <div>STS 41-C 04/06/84 - 04/13/84</div> <div>STS 41-B 02/03/84 - 02/11/84</div> <div>STS-8 08/30/83 - 09/05/83</div> <div>STS-7 06/18/83 - 06/24/83</div> <div>STS-6 04/04/83 - 04/09/83</div>	<div>STS-65 Launched 07/06/94</div> <div>STS-62 03/04/94 - 03/18/94</div> <div>STS-58 10/18/93 - 11/01/93</div> <div>STS-55 04/26/93 - 05/06/93</div> <div>STS-52 10/22/92 - 11/1/92</div> <div>STS-50 06/25/92 - 07/09/92</div> <div>STS-40 06/05/91 - 06/14/91</div> <div>STS-35 12/02/90 - 12/10/90</div> <div>STS-32 01/09/90 - 01/20/90</div> <div>STS-28 08/08/89 - 08/13/89</div>	<div>STS-60 02/03/94 - 02/11/94</div> <div>STS-51 09/12/93 - 09/22/93</div> <div>STS-56 04/08/93 - 04/17/93</div> <div>STS-53 12/2/92 - 12/9/92</div> <div>STS-42 01/22/92 - 01/30/92</div> <div>STS-48 09/12/91 - 09/18/91</div> <div>STS-39 04/28/91 - 05/06/91</div> <div>STS-41 10/06/90 - 10/10/90</div> <div>STS-31 04/24/90 - 04/29/90</div> <div>STS-33 11/22/89 - 11/27/89</div>	<div>STS-46 7/31/92 - 8/8/92</div> <div>STS-45 03/24/92 - 04/02/92</div> <div>STS-44 11/24/91 - 12/01/91</div> <div>STS-43 08/02/91 - 08/11/91</div> <div>STS-37 04/05/91 - 04/11/91</div> <div>STS-38 11/15/90 - 11/20/90</div> <div>STS-36 02/28/90 - 03/04/90</div> <div>STS-34 10/18/89 - 10/23/89</div> <div>STS-30 05/04/89 - 05/08/89</div> <div>STS-27 12/02/88 - 12/06/88</div>	<div>STS-59 04/09/94 - 04/20/94</div> <div>STS-61 12/2/93 - 12/13/93</div> <div>STS-57 6/21/93 - 7/1/93</div> <div>STS-54 01/13/93 - 01/19/93</div> <div>STS-47 09/12/92 - 09/20/92</div> <div>STS-49 05/07/92 - 05/16/92</div>
OV-099 Challenger (10 flights)	OV-102 Columbia (16 flights)	OV-103 Discovery (18 flights)	OV-104 Atlantis (12 flights)	OV-105 Endeavour (6 flights)

# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
202 358-1600



Ed Campion  
Headquarters, Washington, D.C.  
(Phone: 202/358-1778)

For Release

July 12, 1994

Debra Rahn  
Headquarters, Washington, D.C.  
(Phone: 202/358-1639)

Kyle Herring  
Johnson Space Center, Houston  
(Phone: 713/483-5111)

RELEASE: 94-115

## **ASTRONAUT READY TO REPLACE CAMERON AS NASA MANAGER IN RUSSIA**

Astronaut William F. Readdy will replace Kenneth D. Cameron (Colonel, USMC) as NASA manager of operational activities at Star City, Russia. As Director of Operations, Russia, Readdy will work with Russian trainers, engineers and flight controllers to support the training of NASA astronauts at Gagarin Cosmonaut Training Center, Star City, and to enhance continued cooperation between NASA and Russia's Space Agency (RSA).

Readdy's primary responsibilities will include the support of U.S. astronauts and their families currently living in Star City. He also will monitor the current training program as well as develop a syllabus for Shuttle crews training to dock with the Mir space station. In addition, he will establish and maintain the operational relationships required to help develop plans and procedures which support the long-term, joint operations between NASA, RSA and Star City.

Readdy will join fellow astronauts Norman E. Thagard, M.D., and Bonnie J. Dunbar, Ph.D., who have been training in Star City since February as the prime and backup crew members for a 3-month flight aboard Mir. Thagard is scheduled to be launched aboard a Soyuz spacecraft March 1, 1995. Following his three-month stay on Mir, the crew of mission STS-71, which will include Dunbar as a mission specialist, will dock Space Shuttle Atlantis to Mir. It will be the first of up to 10 Shuttle visits that will be made to the Russian space station during the 1995-1997 time frame.

- more -

Readdy has flown on two Shuttle missions, STS-42 in January 1992 and STS-51 in September 1993 -- both aboard Discovery. On the STS-42 flight, Readdy participated in various scientific experiments carried out as part of the first International Microgravity Laboratory (IML-1) mission. As the pilot of STS-51, Readdy participated in the deployment of the Advanced Communications Technology Satellite (ACTS), and the deployment and retrieval of the Astro SPAS (Shuttle Pallet Satellite). He also helped supervise a seven-hour spacewalk designed to evaluate tools and techniques used during the Hubble Space Telescope servicing mission and on future space missions.

A Captain in the U.S. Naval Reserve, Readdy earned a bachelor of science degree in aeronautical engineering from the Naval Academy in 1974.

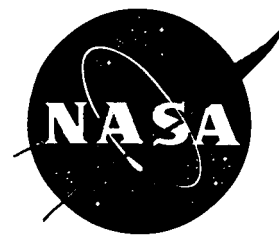
Cameron also has flown twice on the Shuttle. His first flight was on Atlantis' STS-37 mission in 1991 to deploy the Compton Gamma Ray Observatory. His second mission was on Discovery's STS-56 flight in 1993 to continue studies of the Earth's atmosphere as part of a series of missions called Atmospheric Laboratory for Applications and Science (ATLAS). Cameron will return to the Johnson Space Center in Houston, and is expected to command another Shuttle mission in the near future.

-end-

# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
202 358-1600



For Release

Laurie Boeder  
Headquarters, Washington, D.C.  
(Phone: 202/358-1898)

July 13, 1994

RELEASE: 94-116

## **WELCH NAMED NEWS CHIEF AT NASA HEADQUARTERS**

Brian Welch, a veteran public affairs officer for the space agency, has been named Chief of News and Information at NASA Headquarters, Washington, D.C.

Welch began his NASA career as a public affairs cooperative education student at the Langley Research Center, Hampton, Va., in 1979. In 1981, he moved to the Johnson Space Center (JSC), Houston, Texas, to become editor of the center newspaper, the Space News Roundup.

In 1984, he became a public affairs mission commentator, providing real-time descriptions from the Mission Control Center during Space Shuttle flights. He also served as manager of the JSC mission commentary team and as a newsroom manager at JSC during Shuttle flights. In 1993, he served a ten-month tour of duty at NASA Headquarters as speech writer for NASA Administrator Daniel S. Goldin.

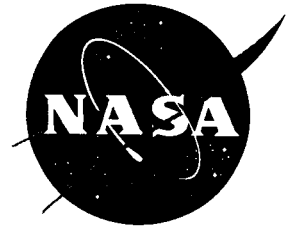
Welch is a graduate of Murray State University, Murray, Ky., and a native of Fulton, Ky.

-end-

# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
202 358-1600



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For Release

Myron Webb  
Stennis Space Center, Miss.  
(Phone: 601/688-3341)

July 14, 1994

RELEASE: C94-aa

## **LOCKHEED SELECTED FOR STENNIS SPACE CENTER CONTRACT**

NASA has selected a team led by Lockheed Space Operations, Inc., Titusville, Fla., for final negotiations leading to award of a seven-year, cost-plus-award-fee contract to provide propulsion test and technical services at the John C. Stennis Space Center (SSC) in Hancock County, Mississippi.

The total cost for the services is estimated by Lockheed to be \$157 million for the seven-year period, plus an additional \$197 million for options that NASA may exercise during performance of the contract. The precise contract value will be determined in negotiations between Lockheed and NASA.

Lockheed will provide a broad range of test and technical services to support NASA's propulsion test programs at SSC, including the Space Shuttle Main Engine program; NASA's research and development programs in remote sensing and other space applications; and programs of other resident Federal and State agencies engaged in space, oceanography, and environmental programs at SSC.

Other members of the Lockheed team include Cimarron Software Services, Inc., Houston, Texas; Datastar, Inc., Picayune, Miss.; GB Tech, Inc., Houston; and Lockheed Engineering & Science Company, Houston.

SSC is NASA's primary test facility for large propulsion systems, and serves as the agency's lead center for commercial remote sensing programs. NASA also functions as the host agency for 22 other Federal and State agencies located at SSC.

-end-

# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
202 358-1600



Donald Savage  
Headquarters, Washington, D.C.  
(Phone: 202/358-1547)

For Release

July 14, 1994

Michael Finneran  
Goddard Space Flight Center, Greenbelt, Md.  
(Phone: 301/286-5565)

Lynn Simarski  
National Science Foundation, Arlington, Va.  
(Phone: 703/306-1070)

Ray Villard  
Space Telescope Science Institute, Baltimore, Md.  
(Phone: 410/338-4514)

NOTE TO EDITORS: N94-51

## **REVISED MEDIA BRIEFING SCHEDULE FOR COMET SHOEMAKER-LEVY 9**

The first briefing on the impact of Comet Shoemaker-Levy 9 with Jupiter will begin on Saturday, July 16, at 7:30 p.m. EDT at the Space Telescope Science Institute (STScI), Baltimore, Md. Coverage will feature Eugene and Carolyn Shoemaker and David Levy, co-discoverers of the comet.

The first fragment of the comet, which is one of the smallest and dimmest of the 21 fragments, will impact Jupiter just before 4 p.m. EDT, July 16, on the side of Jupiter facing away from Earth. Shortly afterwards, the point of impact will rotate into view as seen from Earth, and the Hubble Space Telescope (HST) will image the impact area. The data will be downlinked around 7:30 p.m. EDT.

A press briefing will be held at 10 p.m. EDT at STScI during which scientists will discuss the first image of the impact area. The entire Saturday program beginning at 7:30 p.m. EDT, and all scheduled briefings through July 22, will be broadcast live on NASA Television with two-way question-and-answer capability for reporters covering the briefings from participating NASA centers. For the July 16 briefing, media should fax accreditation requests to STScI at 410/338-4579.

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In addition to the GSFC Comet Impact newsroom, which will be open 24 hours a day from July 16-22 for briefing coverage, the other participating NASA centers are Headquarters in Washington, D.C.; the Kennedy Space Center, Fla.; the Marshall Space Flight Center, Huntsville, Ala., and the Jet Propulsion Laboratory, Pasadena, Calif. The Johnson Space Center, Houston, Texas, will be open for TV viewing only on Saturday, and will begin complete coverage, including two-way Q&A capability for reporters, with Sunday morning's 10 a.m. EDT briefing. Journalists are asked to call the Jet Propulsion Laboratory newsroom at (818) 354-5011 to confirm scheduling of TV events there.

On Sunday morning, July 17, at 10:00 a.m. EDT, a press briefing will be held at GSFC. The briefing will include more information on the initial fragment (fragment 'A') as well as available information from HST and other observatories which observed fragments B, C and D. Panelists will include Eugene and Carolyn Shoemaker, David Levy and other science team members.

The complete schedule of briefings is listed below. (\* Denotes change from previous schedule.)

<b>JULY DATE</b>	<b>TIME (EDT)</b>	<b>EVENT/LOCATION</b>
Sat. 16	7:30 p.m. *	Briefing: Observing Campaign Begins Panelists: Eugene and Carolyn Shoemaker and David Levy Location: Space Telescope Science Inst.
Sat. 16	10:00 p.m.	Press Briefing: First Impact Image Release Location: Space Telescope Science Inst.
Sun. 17	10:00 a.m. *	Press Briefing at GSFC
Mon. 18	8:00 a.m.	Press Briefing at GSFC
Tue. 19	8:00 a.m.	Press Briefing at GSFC
Wed. 20	12:00 noon	Press Briefing at GSFC
Thur. 21	8:00 a.m.	Press Briefing at GSFC
Fri. 22	9:30 a.m.	Press Briefing at GSFC (Subject to change as STS-65 landing events warrant)
Sat. 23	8:00 a.m.	Press Briefing at GSFC

Media wishing to attend the GSFC briefings must have valid press credentials and a photo ID. Media representatives who are not U.S. citizens must contact the Goddard Office of Public Affairs at 301/286-8955 before registering.

The Goddard Comet Impact newsroom will be the central location providing coverage of observations and images from the worldwide network of ground-based observatories and spacecraft taking part in the NASA/National Science Foundation observing project. Scientists will be on hand at the newsroom to answer questions, or interviews can be arranged as needed. Press materials, artwork and video relating to the event will be available to media.

NASA TV is carried on Spacenet 2, transponder 5, channel 9, 69 degrees West. The transponder frequency is 3880 MHz, the audio is 6.8 MHz, and polarization is horizontal.

### **Electronic Distribution of Materials**

Current HST and other observatory images and information are available through the Internet and NASA's Spacelink. As new information and images become available, they will be posted to these services:

Spacelink: Use Telnet to access at: [spacelink.msfc.nasa.gov](http://spacelink.msfc.nasa.gov). If you are a new user, register with the password "newuser." Use the "Goto" feature and enter "Shoemaker-Levy." To access Spacelink using a modem, direct dial 205/544-0028.

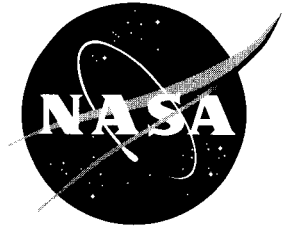
Internet: To access using World Wide Web (WWW), the Uniform Resource Locator (URL) address for Jet Propulsion Laboratory's WWW Shoemaker-Levy home page is: <http://newproducts.jpl.nasa.gov/sl9/sl9.html>

The WWW server contains NASA press releases, current impact and press event schedules, current HST and other spacecraft and ground-based observatory comet images, and information on spacecraft and ground-based observing programs.

# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
202 358-1600



Charles Redmond  
Anchorage, Alaska  
(Phone: 907/229-6724)

For Release

July 15, 1994

David E. Steitz  
Headquarters, Washington, D.C.  
(Phone: 202/358-1730)

NOTE TO EDITORS: 94-52

## **DANTE ACTIVITIES AT ALASKA'S MT. SPURR UPDATED**

The Dante robot project team in Anchorage, Alaska, has produced an updated schedule for mission activities for the robotic exploration of the active volcano at Mt. Spurr:

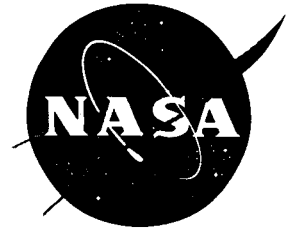
- July 15-16:** Computer and communications team members will establish a control center for Dante operations in a trailer at the Frontier Building, 36th and C Sts., Anchorage. Other team members will prepare Dante for a field test down a steep slope in Anchorage, utilizing satellite communications to test system integrity.
- July 21-22:** Dante and support equipment will be prepared for airlift to the Chugach Power Cooperative's gas-turbine generator plant runway at Beluga, Alaska, approximately 55 miles southwest of Anchorage (across Cook Inlet) and about 22 miles southeast of Mt. Spurr's crater peak.
- July 23-24:** Dante and support equipment will be airlifted to Beluga, where Army National Guard helicopter will hoist Dante and support equipment to crater rim. Equipment will be tested and verified as functional. The descent of Dante into the volcano will begin at the earliest opportunity, depending on daylight and weather conditions. Dante operations are expected to continue through July 28.

-end-

# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
202 358-1600



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For Release

Michael Finneran  
Goddard Space Flight Center, Greenbelt, Md.  
(Phone: 301/286-5565)

July 15, 1994

Don Savage  
Headquarters, Washington, D.C.  
(Phone: 202/358-1547)

NOTE TO EDITORS: N94-53

## **GODDARD COMET IMPACT NEWSROOM HOURS OF OPERATION UPDATE**

The Goddard Space Flight Center Comet Impact newsroom will open at 6 a.m. EDT, Sunday, July 17, and remain open through the 8 a.m. EDT press briefing on Saturday, July 23. Goddard's newsroom phone number will be 301/286-2300.

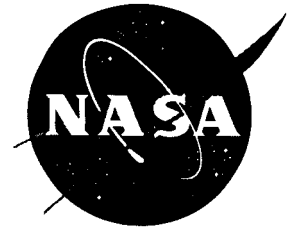
Media can cover the Saturday, July 16 comet press briefing at the Space Telescope Science Institute, Baltimore, Md., or at NASA Headquarters, Washington, D.C. The Space Telescope Science Institute public affairs office can be reached at 410/338-4562. All other NASA center hours of operation remain as stated in the Thursday, July 14 press release.

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# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
202 358-1600



For Release

Terri Sindelar-Hudkins  
Headquarters, Washington, D.C.  
(Phone: 202/358-1977)

July 15, 1994

NOTE TO EDITORS: N94-54

## **NASA LAUNCHES EDUCATION PROGRAM FOR INNER CITY STUDENTS**

NASA Administrator Daniel S. Goldin, Congresswoman Maxine Waters and two NASA astronauts will kick-off an education project in Los Angeles designed to increase minority participation in the field of Earth sciences. The event will take place Saturday, July 16, noon to 3 p.m. PDT, at the California State Science Museum, Armory Building, Muses Room, 700 State Drive, Los Angeles.

The event will include opening remarks and an overview of the program from Congresswoman Waters and NASA Administrator Goldin. NASA astronauts Winston E. Scott and Michael E. Lopez-Alegria (a native Californian) will each make audiovisual presentations. Eighty high school students and seven teachers from Los Angeles inner city communities will participate in the project.

Other presenters include Dr. Yvonne Freeman, NASA's Associate Administrator for Equal Opportunity Programs; Dr. Samuel Jackson, Vice President of Student Services at Central State University (CSU), Wilberforce, Ohio; and two college students participating in NASA's Minority Students in Science and Engineering program.

The project will include students spending four weeks at CSU attending pre-college lectures in math, computer and Earth science, interacting with college students and professionals in Earth science programs, attending seminars and taking field trips.

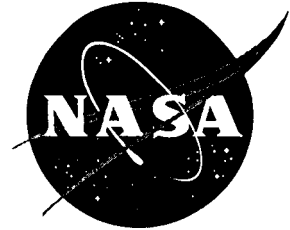
Students also will tour Historically Black Colleges and Universities and Hispanic Serving Institutions in Alabama, Georgia, Ohio, Pennsylvania, Tennessee and New York to learn of other Earth science research activities, to visit state-of-the-art laboratories and to learn about degree options and admissions requirements of the institutions. The program also involves teacher workshops for curricula development.

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# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
202 358-1600



For Release

Mark Hess  
Headquarters, Washington, D.C.  
(Phone: 202/358-0902)

July 15, 1994

RELEASE: 94-117

## **STATION CONTROL BOARD RATIFIES IMPROVED ASSEMBLY SEQUENCE**

The Space Station Control Board (SSCB) this week approved a revised assembly sequence that provides significantly more power for the United States laboratory, provides an earlier U.S. capability for essential Space Station systems and produces hardware in an efficient and cost effective manner while still meeting the \$2.1 billion annual spending cap.

Space Station officials began work on a revised assembly sequence several months ago to address Administration and Congressional concerns about power and U.S. capability to provide redundancy for critical Station systems early in the assembly sequence.

"We believe this assembly sequence satisfies those concerns," said Randy Brinkley, Space Station Program Manager. "And it does it in a way that is good for the program."

Brinkley said the revised assembly sequence will result in key improvements:

- It achieves a schedule that produces hardware efficiently within the annual funding constraint.
- It reduces risk by relying on a well defined U.S. photovoltaic array module to provide electrical power for the Space Station.
- It increases from eight kilowatts to 13 kilowatts the average maximum power that is available to the U.S. lab when it is delivered to the Space Station. This is critical to the user community as some high power experiments may now be flown earlier.

Brinkley said a number of factors drove the revised assembly sequence. "We wanted to increase the amount of power available for the U.S. lab, establish an earlier U.S. capability for essential Station systems, and stay within the funding cap, all of which we accomplished."

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Brinkley added, "when we laid all those changes out, it forced us to delay slightly the launch of the laboratory module. But we think this was a reasonable trade and will actually provide a larger payoff in the long run. We determined it was better to have sufficient power to run the lab, rather than to have the lab up in space and not have the power to adequately use it."

Brinkley said other key milestones have not been affected. "The first element launch has not changed; it is still December 1997. The Japanese experiment module launch has not been affected, and the assembly complete milestone is still June 2002."

The SSCB meeting was held Tuesday, July 12, at the Johnson Space Center, Houston. The Board is comprised of Space Station program management, international partners and Boeing Space Station team management.

"The early power capability will be achieved by taking a U.S. solar array, moving it up in the launch sequence, and attaching it to a small truss on top of the U.S. node," said Bill Shepherd, deputy manager, Space Station Program Office. Shepherd said toward the end of the assembly sequence the solar array will be relocated to its permanent position at the end of the truss assembly.

The small truss, which supports the early solar array, will remain in place on the node and also will house control moment gyros and communication antennas. The laboratory module flight is now set for November 1998, after the early solar array installation.

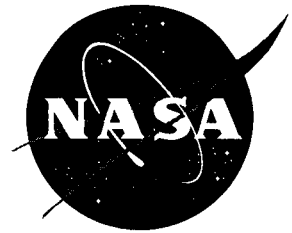
In addition to agreeing to the improved assembly sequence, the SSCB concurred with plans to purchase the power and propulsion module known as the "FGB" or "energy block" from Russia's Krunichev enterprise. Purchase of the FGB, at a price to be negotiated, assured its availability at the outset of Station assembly and adds redundancy in guidance, navigation and control and reboost capability. The Board also baselined an assembly sequence that includes the European Space Agency's plans to launch its attached pressurized laboratory module on the European Ariane vehicle instead of the Space Shuttle.

"The net result of today's actions," said Space Station Program Director Wilbur Trafton, "is that we have increased significantly the electrical power available for research through the remainder of the Station assembly sequence. We also have maintained our crucial schedule for the first element launch and assembly complete milestones while remaining within our budget limits."

# NASA News

National Aeronautics and  
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202 358-1600



For Release

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Headquarters, Washington, D.C.  
(Phone: 202/358-4733)

July 15, 1994

H. Keith Henry  
Langley Research Center, Hampton, Va.  
(Phone: 804/864-6124)

RELEASE: 94-118

## **BOEING AND DOUGLAS TEAM UP IN HIGH-SPEED AERO CONTRACT**

NASA today announced the award of a \$440 million contract that marks the first time America's two leading airplane manufacturers have teamed up to develop technologies for a potential future U.S. High-Speed Civil Transport (HSCT).

This precedent-setting action joins Boeing Commercial Airplane Group, Seattle, Wash., with McDonnell Douglas Aerospace, Long Beach, Calif., and other companies to develop airframe technologies for aerodynamics, flight systems and materials and structures.

"Developing the technologies for a future supersonic airliner that will be environmentally friendly and economically successful presents a major challenge and opportunity," said Louis J. Williams, Director of NASA's High-Speed Research (HSR) program. "This contract effectively combines the expertise and capabilities of U.S. industry to accomplish this goal," Williams said.

Boeing has proposed that McDonnell Douglas serve as the company's principle subcontractor. By working together under a single contract, the two companies will be able to reduce redundancies, lower costs and accelerate research, ensuring that the United States remains at the forefront in commercial aerospace competition.

Boeing and McDonnell Douglas, along with General Electric Corp. and Pratt & Whitney, previously had competed with NASA via separate contracts in the first phase of the NASA HSR program. Phase I was aimed at developing technologies to address important environmental issues such as the reduction of noise and engine emissions.

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Progress made in Phase I has led to Phase II of the program, which focuses on moving technology concepts out of the laboratory and into practical applications. Phase II will focus on developing and providing the technology necessary to make a future supersonic airliner economically practical as well as environmentally compatible.

In June, NASA awarded Honeywell Inc. \$75 million to conduct flight deck systems research and technology development for the potential HSCT, and last year the agency selected GE and Pratt & Whitney to negotiate a contract for propulsion technologies.

The HSCT, a commercial supersonic aircraft, could fly 300 passengers across the Pacific or Atlantic Oceans at 2.4 times the speed of sound -- cutting travel time by more than half. The new aircraft will fly faster than the Concorde, go nearly twice as far and be able to carry three times as many passengers.

The second phase also will include performance evaluations of representative engine components, structural verification tests of new engine and airframe materials and flight tests of better wing designs and new cockpit technology.

The flight deck systems effort will develop controls, guidance and synthetic vision technology, such as might be used to allow the pilot to fly the aircraft in all weather conditions with a "no-nose-droop" design, a significant improvement over the first generation Concorde.

The main objective of the aerodynamics effort is to develop technology to increase the supersonic and subsonic cruise performance of the potential transport. Researchers will use wind tunnels and computational techniques to look at several different designs for the transport's components, primarily the wing and the horizontal tail.

Researchers in materials and structures will develop new metallic alloys and composite materials for the airframe that can withstand temperatures of up to 350 degrees Fahrenheit at cruise speeds. Also, researchers will develop technology to produce wing and fuselage structures that are 33 percent lighter in weight than comparable Concorde structures, while also economical to manufacture and highly durable.

NASA's HSR program, begun in 1990, is the cornerstone of NASA aeronautics research for the 1990s. Funding for the agency's program, which addresses only high-risk, high-priority technology, totalled \$197 million this fiscal year, with comparable investments planned through the end of the

-3-

century. American industry is making parallel investments to complete the high-risk technology, and they will decide whether building a next-generation supersonic transport makes good business sense.

NASA's Office of Aeronautics, Washington, D.C., directs the High-Speed Research program. NASA's Langley Research Center, Hampton, Va., is the agency's lead center for overall technical project implementation, with the Lewis Research Center, Cleveland, leading the propulsion technology development.

The Dryden Flight Research Center, Edwards, Calif., is working on laminar flow control, flight testing and sonic boom research for the HSR program, while the Ames Research Center, Mountain View, Calif., is working on flight deck technology, sonic boom and aerodynamics research.

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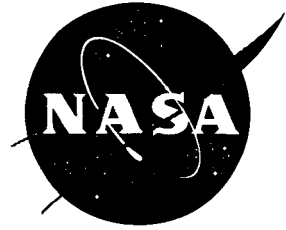
EDITORS NOTE: A videotape describing NASA's High-Speed Research program is available to media representatives by faxing a request to 202/358-4333. The video length is 1 minute and 11 seconds. Still photos of the Boeing and McDonnell Douglas concepts of the High-Speed Civil Transport are available by faxing a request to the same number.

Color:	B&W:
McDonnell Douglas: 94-HC-184	94-H-198
Boeing: 94-HC-185	94-H-199

# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
202 358-1600



For Release

Debra J. Rahn  
Headquarters, Washington, D.C.  
(Phone: 202/358-1639)

July 18, 1994

RELEASE: 94-119

## **NASA AND UKRAINE SPACE AGENCY AGREE ON AREAS OF SPACE COOPERATION**

NASA and the National Space Agency of Ukraine (NSAU) agreed July 13 to explore possible cooperation in remote sensing and Earth sciences, telemedicine, space biology, space welding, advanced concepts and technology, and student and scientist exchanges.

"These proposed activities are a significant first step in establishing U.S. and Ukrainian cooperation in space," said Robert W. Clarke, NASA Associate Administrator for Policy Coordination and International Relations. The activities follow discussions held between NASA Administrator Daniel S. Goldin and Ukrainian Deputy Prime Minister Valeriy Shmarov earlier this year.

Details of discussions that were held at NASA Headquarters, NASA's Goddard Space Flight Center, Greenbelt, Md., and the John F. Kennedy Space Center in Florida on July 6-15, 1994, included the following:

### **o Remote Sensing and Earth Sciences:**

Shuttle Imaging Radar (SIR-C) imagery of Ukraine: NASA has included a list of sites provided by NSAU as targets of opportunity for the August 1994 SIR-C Shuttle mission. NSAU will conduct airborne radar surveys of these sites during the mission.

Chernobyl Studies: Discussions were held on a possible joint project to study the Chernobyl region using U.S. Landsat imagery and various Ukrainian data from ground measurements and from remote sensing platforms.

o Telemedicine: Cooperation in this area may include computer connectivity, voice/fax, and videoconferencing capabilities for furthering medical science and medical education, as well as the clinical telemedicine capabilities required for patient examinations and evaluations in Ukraine and the United States.

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- o Space Biology: This may include data and scientist exchanges in flight- and ground-based research, biomedical research, flight hardware, access to space flight, unique ground facilities, science and technology application, and advanced life support.

- o Space welding: A possible NASA/Ukraine Joint Flight Demonstration of the Ukrainian Universal Hand Tool (UHT) was discussed. If approved, NASA will lease the UHT from the Paton Institute, Kiev, Ukraine. The institute is a world leader in space welding technologies which could offer viable techniques for assembly and repair of large space structures. A flight demonstration project of the UHT could begin as early as October 1994 with an estimated flight date on the Space Shuttle planned for late 1997.

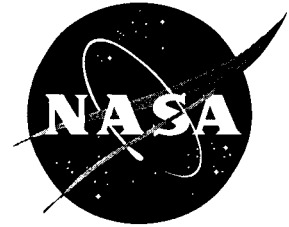
- o Advanced concepts and technology: This includes exploring possible collaborative areas in advanced concepts and technology, especially in the areas of electrophoresis, protein crystal growth, organic separation, animal and plant productivity, environmental controls, agricultural biotechnology, and electron beam processing of metallic and semiconductor materials.

Clarke was the head of the U.S. Delegation and Valeriy G. Komarov, Deputy Director General, NSAU, was the head of the Ukrainian delegation.

# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
202 358-1600



For Release

Brian Welch  
Headquarters, Washington, D.C.  
(Phone: 202/358-1600)

July 20, 1994

RELEASE: 94-121

## HEADQUARTERS NEWS DISTRIBUTION GOES ON-LINE JULY 25

Distribution of news releases and other informational materials from NASA Headquarters will take a giant leap into the Information Age starting Monday, July 25.

As of that date, Headquarters will no longer distribute news releases, contract announcements or notes-to-editors by mail. Use of electronic distribution services such as the Internet, Compuserve and Fax-on-Demand will become the primary means of informing the news media and the public about NASA activities and programs. Text-only versions of mission press kits also will be available via on-line services.

"We are excited by the possibilities inherent in this new way of doing business," said Geoffrey H. Vincent, Deputy Associate Administrator for Public Affairs and head of the Agency's public affairs Internet steering group. "Over time, this change will save the taxpayers hundreds of thousands of dollars and allow us to meet our customers' needs in a much more effective and efficient manner."

The changeover to electronic distribution of news material has been planned for almost a year, Vincent noted. "The Internet is quickly evolving, and we hope to evolve with it," he said. "In the years ahead, vast amounts of information on space exploration, from news releases to historical documents and photographs -- eventually even video -- will be available not just to reporters, but to teachers, students and anyone else who wishes to access it."

Use of the Internet to obtain information on space-related topics is one of the fastest growing aspects of the service, he added. "Since July 8, for example," Vincent said, "there have been more than 90,000 inquiries on a computer server at the Jet Propulsion Laboratory for information on the collision of Comet Shoemaker-Levy 9 with the planet Jupiter. This is just one example of the tremendous interest that exists, and the virtually unlimited possibilities of this new technology."

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Although the primary means of news distribution will be by on-line services, news media currently on the Headquarters distribution list will continue to receive news releases by fax. Press kits will continue to be sent by mail for the foreseeable future, but that practice ultimately will be phased out as technological advances permit.

### **ACCESS BY INTERNET**

The NASA Headquarters Internet database will contain NASA news releases, mission press kits, contract announcements, notes-to-editors, fact sheets and other publications.

NASA press releases can be obtained automatically by sending an Internet electronic mail message to [domo@hq.nasa.gov](mailto:domo@hq.nasa.gov). In the body of the message (not the subject line) users should type the words "subscribe press-release" (no quotes). The system will reply with a confirmation via E-mail of each subscription. A second automatic message will include additional information on the service.

Informational materials also will be available from a data repository known as an anonymous FTP (File Transfer Protocol) server at [ftp.pao.hq.nasa.gov](ftp:pao.hq.nasa.gov) under the directory /pub/pao. Users should log on with the user name "anonymous" (no quotes), then enter their E-mail address as the password. Within the /pub/pao directory there will be a "readme.txt" file explaining the directory structure.

### **ACCESS BY FAX**

An additional service known as fax-on-demand will enable users to access NASA informational materials from their fax machines. Users calling (202) 358-3976 may follow a series of prompts and will automatically be faxed the most recent Headquarters news releases they request.

### **ACCESS BY COMPUERVE**

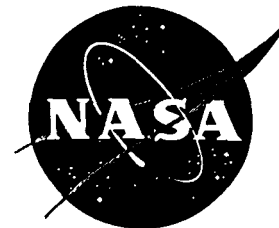
Users with Compuserve accounts can access NASA press releases by typing "GO NASA" (no quotes) and making a selection from the categories offered.

The Headquarters Newsroom also will operate an automated telephone system for users with problems accessing these information resources. The number is (202) 358-4043.

# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
202 358-1600



For Release

Brian Dunbar  
Headquarters, Washington, D.C.  
(Phone: 202/358-1547)

July 21, 1994

Diane Ainsworth  
Jet Propulsion Laboratory, Pasadena, Calif.  
(Phone: 818/354-5011)

RELEASE: 94-122

## **APOLLO REFLECTORS CONTINUE TO AID STUDIES OF THE MOON**

A quarter of a century ago, Apollo 11 astronauts Neil Armstrong and Buzz Aldrin deployed a variety of scientific experiments in the fine powder of the Sea of Tranquility.

Among those devices was a laser ranging retroreflector, which, a generation later, is still yielding fundamental scientific data.

Scientists who analyze data from the Lunar Laser Ranging Experiment have reported some watershed results from these long-term experiments, said team investigator Dr. Jean Dickey at NASA's Jet Propulsion Laboratory, Pasadena, Calif. The team's findings appear in this week's issue of *Science*, which commemorates the silver anniversary of the Apollo 11 lunar landing.

Laser ranging has made possible a wealth of new information about the dynamics and structure of the Moon. Among many new observations, scientists now believe that the Moon may harbor a liquid core. The theory has been proposed from data on the Moon's rate of rotation and very slight bobbing motions caused by gravitational forces from the Sun and Earth.

Other recent findings from the laser ranging experiments include:

- Verification of Einstein's theory of relativity, which states that all bodies fall with the same acceleration regardless of their mass.
- The length of an Earth day has distinct small-scale variations, changing by about one thousandth of a second over the course of a year. These changes are caused by the atmosphere, tides and the Earth's core.

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- Precise positions of the laser ranging observatories on Earth are slowly drifting as the crustal plates on Earth drift. An observatory in Hawaii is seen to be drifting away from an observatory in Texas.

- Ocean tides on Earth have a direct influence on the Moon's orbit. Measurements show that the Moon is receding from Earth at a rate of about 1.5 inches (about 3.8 centimeters) per year.

- Lunar ranging has greatly improved scientists' knowledge of the Moon's orbit, enough to permit accurate analyses of solar eclipses as far back as 1400 B.C.

Continued improvements in range determinations and the need for monitoring the details of the Earth's rotation will keep the lunar reflector experiments in service for years to come, Dickey said.

"Using the Lunar Laser Ranging Experiment, we have been able to improve, by orders of magnitude, measurements of the Moon's rotation," Dickey said. "We also have strong evidence that the Moon has a liquid core, and laser ranging has allowed us to determine with great accuracy the rate at which the Moon is gradually receding from the Earth."

The first laser ranging retroreflector was positioned on the Moon in 1969 by the Apollo 11 astronauts so that it would point toward Earth and be able to reflect pulses of laser light fired from the ground.

By beaming laser pulses at the reflector, scientists have been able to determine the round-trip travel time of a laser pulse and provide the distance between these two bodies at any given time down to an accuracy of about 1 inch (about 2.5 centimeters).

The laser reflector consists of 100 fused silica half-cubes, called corner cubes, mounted in an 18-inch-square (46-centimeter) aluminum panel. Each corner cube is 1.5 inches (3.8 centimeters) in diameter. Corner cubes reflect a beam of light directly back toward the point of origin, allowing scientists to measure the Earth-Moon separation and study the dynamics of the Earth, the Moon and the Earth-Moon system.

Once the laser ranging experiments began to yield valuable results, more reflectors were left on the Moon. A reflector identical to the Apollo 11 mission reflector was left by the Apollo 14 crew, and a larger reflector using 300 corner cubes was placed on the Moon by the Apollo 15 astronauts. French-built reflectors were also left on the Moon by the unmanned Russian Lunakhod 2 mission.

Several observatories have regularly ranged the Moon with these reflectors: one is located at McDonald Observatory near Fort Davis, Texas; another is located atop the extinct Haleakala volcano on the island of Maui in Hawaii; another is located in southern France near Grasse.

The Lick Observatory in northern California also has been used in the past for the lunar laser ranging experiments, and ranging programs have been carried out in Australia, Russia and Germany. Despite the difficulty of detecting reflected laser light from the Moon, Dickey said, more than 8,300 ranges have been measured over the last 25 years.

"Lunar ranging involves sending a laser beam through an optical telescope," Dickey said. "The beam enters the telescope where the eye piece would be, and the transmitted beam is expanded to become the diameter of the main mirror, then bounced off the surface toward the reflector on the Moon."

The reflectors are too small to be seen from Earth, so even when the beam is precisely aligned in the telescope, actually hitting a lunar retroreflector array is technically challenging. At the Moon's surface the beam is roughly four miles wide. Scientists liken the task of aiming the beam to using a rifle to hit a moving dime two miles away.

Once the laser beam hits a reflector, scientists at the ranging observatories use extremely sensitive filtering and amplification equipment to detect the return signal, which is far too weak to be seen with the human eye. Even under good atmospheric viewing conditions, only one photon -- the fundamental particle of light -- will be received every few seconds.

The range accuracy of these reflectors has been improved over the lifetime of the lunar laser ranging experiments, the team noted in *Science*. While the earliest ranges had accuracies of several yards (or meters), continuing improvements in the lasers and the detection electronics have led to recent measurements that are accurate to about 1 inch (2.5 centimeters).

From the ranging experiments, scientists know that the average distance between the centers of the Earth and the Moon is 239,000 miles (382,000 kilometers), showing that modern lunar ranges have relative accuracies of better than one part in ten billion.

"This level of accuracy represents one of the most precise distance measurements ever made," Dickey said. "The degree of accuracy is equivalent to determining the distance between Los Angeles and New York to one fiftieth of an inch."

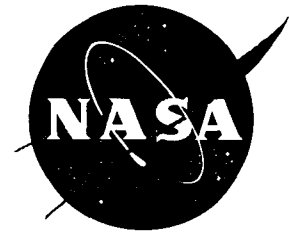
At JPL the lunar ranging analysis is carried out by JPL scientists Drs. Jean Dickey, James G. Williams, X X Newhall and Charles F. Yoder. The work is sponsored jointly by the Astrophysics Division of NASA's Office of Space Science and the Solid Earth Science Branch of NASA's Mission to Planet Earth Office, Washington, D.C.

Additional work is done at the Joint Institute for Laboratory Astrophysics at the University of Colorado at Boulder; at the University of Texas at Austin; and at Observatoire de la Cote d'Azur, Grasse, France.

# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
202 358-1600



For Release

Ed Campion  
Headquarters, Washington, D.C.  
(Phone: 202/358-1778)

July 26, 1994

NOTE TO EDITORS: N94-57

## **STS-68 PRE-FLIGHT BRIEFINGS SET**

Pre-flight briefings for the STS-68 Space Shuttle mission aboard Endeavour are scheduled for Thursday, July 28.

STS-68, currently targeted for launch from the Kennedy Space Center, Fla., on August 18, 1994, will be the second flight of the Space Radar Laboratory (SRL) in Endeavour's cargo bay, continuing a global study of how the Earth's environment is changing, distinguishing human-induced changes from other kinds of change.

The first two briefings will originate from the Johnson Space Center (JSC) in Houston, Texas. Those briefings will include a mission overview by Lead Flight Director Chuck Shaw and Mission Manager Lew Wade beginning at 10 a.m. EDT, and a Measurement of Air Pollution by Satellite overview at 11 a.m. EDT.

A Get Away Special Overview will originate from the Goddard Space Flight Center, Greenbelt, Md., at 11:30 a.m. EDT, followed by an SRL Science Overview from NASA's Jet Propulsion Laboratory in Pasadena, Calif., at 12 noon EDT.

At 2:30 p.m. EDT, the six STS-68 astronauts will discuss their mission in a news conference at JSC.

All briefings will be aired on NASA television with two-way question and answer capability. NASA television is carried on Spacenet 2, transponder 5, channel 9, located at 69 degrees West longitude, with a frequency of 3880 MHz.

-end-

# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
202 358-1600



For Release

J. Headlee  
Headquarters, Washington, D.C.  
(Phone: 202/358-1734)

July 26, 1994

NOTE TO EDITORS: N94-58

## TELEVISION ADVISORY

SUBJECT: "REVITALIZING GENERAL AVIATION "

DATE: Wednesday, July 27, 1994

UPLINK TIMES: 1:30 PM (EDT) and 1:45 PM (EDT)

RUNNING TIME: 1:30 Spot + 6:00 Feature + 5:42 "B" Roll (TRT 14:30)

SATELLITE: Spacenet 2 Transponder 5 (Channel 9)  
C-Band  
Frequency: 3880.0 MHz  
Audio: 6.8  
Down link polarity: Horizontal  
Spacenet 2 is located at 69 degrees West longitude

Two playbacks: 1:30 PM (FULL MIX) 1:45 PM (NAT. SOUND ONLY)

Over the past 10 years, production of single engine aircraft, the foundation of all flight, has declined dramatically in this country. NASA, the FAA and more than 60 U.S. companies are currently forming a partnership to reverse this trend. Its goal is to identify affordable, state-of-the-art technologies that can be incorporated into these planes, making them less complicated and expensive to fly.

If you are unable to down link at the above times, send us a FAX at (202) 358-4333 and we will arrange another satellite feed for you.

-end-

# NASA News

National Aeronautics and  
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202 358-1600



Michael Braukus  
Headquarters, Washington, D.C.  
(Phone: 202/358-1979)

For Release  
July 26, 1994

Diane Farrar  
Ames Research Center, Mountain View, Calif.  
(Phone: 415/604-9000)

RELEASE: 94-123

## **NASA USES SATELLITE DATA TO DETECT LYME DISEASE RISK**

Scientists at NASA's Ames Research Center, Mountain View, Calif., and the New York Medical College (NYMC) in Valhalla, N.Y., are using satellite remote sensing and computer technology to predict the risk of Lyme disease transmission.

"We have successfully used satellite imagery to identify specific types of suburban areas in Westchester County, New York, where the risk of exposure to Lyme disease is high," said Sheri Dister, a research scientist. Dister, with Byron Wood and Louisa Beck, all employees of Johnson Controls World Service, Inc., collaborate on the project at Ames.

The NASA team, with Dr. Durland Fish of NYMC and Westchester County Health Department investigators, combined Landsat imagery and Geographic Information System (GIS) technology, which uses layers of maps to display spatial relationships to map landcover for all of Westchester County to identify types and placement of landscape elements associated with Lyme disease risk.

They found that the higher the proportion of vegetated residential area next to woods within a municipality, the higher the transmission risk. It has been reported that 69 percent of the deer tick bites in Westchester County are acquired by people near their homes.

Lyme disease is transmitted to humans by infected deer ticks. It is now the most commonly reported vector-borne (transmitted by a variety of insects and ticks) disease in the United States. When untreated, it can result in debilitating arthritis, and neurological and cardiac disorders.

"Knowing where the risk of Lyme disease occurs is the first step in prevention -- whether behavioral, spraying for ticks, or vaccination," Fish said.

- more -

"This new method of getting information has given us a complete picture of the high risk areas throughout the county, without sending teams of people into the field," he said. Westchester County covers more than 450 square miles.

The preliminary study used rates of Lyme disease antibodies in the blood of domestic dogs as a measure of exposure risk. Dogs exposed to tick bites produce specific antibodies to Lyme disease. The dogs' infection rate can indicate the risk of Lyme disease transmission in these areas.

NYMC scientists analyzed the percentage of sampled dogs testing positive for Lyme disease in each municipality of Westchester County. Antibody rates increased, they found, from south to north as the character of the countryside changed from urban to rural.

The Ames scientists used Landsat data to characterize this urban-to-rural transition in terms of different types of residential areas and vegetation important for ticks and their hosts.

Overlaying the canine data onto the landscape map showed a significant correlation between the canine exposure rate and the proportion of vegetated residential areas located next to woods. Residential areas not adjacent to woods did not show this same pattern, indicating the importance of the surrounding landscape in mapping residential risk of Lyme disease.

"We found that remote sensing and GIS technologies can be used to map landscape elements for large areas and relate them to Lyme disease risk. We are now looking at residence-level field data in relation to the satellite data to see if we can find a similar pattern at this finer scale," Dister said.

The team is working to develop a predictive model that can be applied to other regions of the Northeast similar to Westchester County.

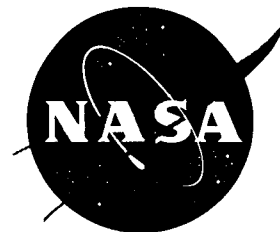
Earlier this year, the U.S. Centers for Disease Control issued a report that suggested using innovative tools for surveillance of emerging and re-emerging infectious diseases in the U.S.

"This particular innovative approach shows the significant contribution NASA can make in the surveillance and prediction of emerging diseases," said Dr. Joan Vernikos, director of NASA's Life and Biomedical Sciences and Applications Division at NASA Headquarters, Washington, D.C. The division, through its Global Monitoring and Disease Prediction Program, supports the use of remote sensing and GIS technologies in public health applications.

# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
202 358-1600



For Release

Donald L. Savage  
Headquarters, Washington, D.C.  
(Phone: 202/358-1727)

July 26, 1994

Kathy Berry  
Geophysical Institute, University of Alaska, Fairbanks  
(Phone: 907/474-7798)

RELEASE: 94-124

## **SPECTACULAR COLOR FLASHES RECORDED ABOVE ELECTRICAL STORMS**

Hundreds of spectacular red and blue flashes of light that extend upward from electrical thunderstorms to altitudes as high as 60 miles (97 km) recently were recorded on video for the first time.

The unusual flashes occurred over thunderstorms in the Midwest between June 28 and July 12 during a NASA-sponsored investigation into the phenomenon. To capture the images, Principal Investigators Davis Sentman and Eugene Wescott, professors at the Geophysical Institute with the University of Alaska, Fairbanks, (UAF) and co-directors of the research project, used special low-light-level cameras aboard two jet aircraft flown out of Oklahoma City.

"The flashes look like the Fourth of July, like Roman candles with fountains," said Sentman. "The video footage we received far exceeded our expectations."

Some of the flashes extend up through the ozone layer into the base of the ionosphere, the region of the upper atmosphere where auroras occur.

Sentman and Wescott captured 19 black-and white images of the flashes above thunderstorms in the Midwest last year. Before that, scientists did not have proof that the flashes existed.

This month, they were able to accurately measure the position and altitude of the flashes and to examine their color and speed for the first time, using two aircraft for triangulation and improved camera systems designed by Project Engineer Daniel Osborne, with the Geophysical Institute. They also were able to identify two distinctly different kinds of flashes, which they call sprites and blue jets.

- more -

Sprites are blood red flashes that appear with bluish tendrils dangling from the bottom of some. The flashes, which last only a few thousandths of a second, extend from above storm clouds up to about 60 miles (97 km) high, reaching the bottom of the ionosphere. The researchers also recorded radio noise that coincided with the sprite flashes. When the recorded signals are played through a speaker, they "pop," a sound that differs from normal lightning discharge signals.

The sprites have been recorded on a TV spectrograph and will be analyzed to determine their atomic and molecular source. Since they are associated with thunderstorms and lightning, scientists suspect the flashes may be a form of electrical discharge. If so, they could present a concern to high-altitude research aircraft.

Blue jets are flashes that appear in narrow beams, sprays, fans or cones of light which give off a blue or purple hue. "To the eye, they resemble material ejected from a high explosive source, the tracks of atomic particles, or rays in a cloud chamber," Wescott said.

Pilots and others have reported seeing blue or green columns of light above thunderstorms for years, but Sentman and Wescott were the first to capture them on video. They recorded about a dozen blue jets over an intense storm in Arkansas on June 30.

The jets appeared to originate at the top of storm clouds and then to travel upward to an altitude of about 20 miles (32 km). They occurred at various angles at speeds ranging from 20 to 60 miles a second (32 to 97 km/s), which is well above the speed of sound, but far below that of light or radio waves.

The scientists coordinated their observations with other groups in Fort Collins, Colorado, Pennsylvania State University and Stanford University, where researchers made video and radio wave observations from the ground. The aircraft were leased by UAF from Aero Air, Inc., Hillsboro, Oregon.

- end -

NOTE TO EDITORS: To illustrate this story, one color and two black and white images and a two minute, 46 second videotape are available to news media by faxing your request to NASA Headquarters Broadcasting and Imaging Branch on 202/358-4333. Photo numbers are:

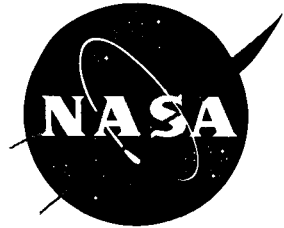
Color:	B & W:
94-HC-186	94-H-200 (B&W image of 94-HC-186)
	94-H-201
	94-H-202

Additional information on observations of the phenomenon can be obtained by faxing NASA Headquarters News and Information Branch on 202/358-4210, requesting Release Number 93-167.

# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
202 358-1600



For Release

Jim Cast  
Headquarters, Washington, D.C.  
(Phone: 202/358-1779)

August 1, 1994

Ernie J. Shannon  
Marshall Space Flight Center, Huntsville, Ala.  
(Phone: 205/544-0034)

RELEASE: 94-125

## **DELTA CLIPPER AGREEMENT SIGNED**

NASA's Marshall Space Flight Center in Huntsville, Ala., has signed a cooperative agreement with McDonnell Douglas Aerospace in Huntington Beach, Calif., to reconfigure the Delta Clipper experimental vehicle (DC-X) using advanced lightweight materials and advanced auxiliary propulsion systems.

The agreement covers a 28-month period beginning this month at a total estimated government funding amount of \$17.6 million, with cost sharing by McDonnell Douglas of \$7.6 million.

The DC-X vehicle was originally developed by McDonnell Douglas under a Department of Defense (DoD) contract. Designed and built in 19 months, it was test-flown five times in 1993 and 1994 and is currently undergoing repairs following minor damage on the last flight.

NASA is acquiring the DC-X from DoD to test new technologies needed to develop a reusable launch vehicle which could assist the Agency's ultimate goal of gaining low-cost access to space.

The focus of the Marshall Center's DC-XA (Delta Clipper - Experimental Advanced) program will be the flight demonstration of an aluminum/lithium liquid oxygen tank, a graphite composite liquid hydrogen tank, a composite intertank, an advanced auxiliary propulsion system and other advanced technology components all replacing existing lower technology hardware.

The first flight of the Marshall-managed DC-XA is scheduled for the spring of 1996. After a series of flights, the vehicle will be returned to Marshall for disassembly and further component testing.

- end -

# NASA News

National Aeronautics and  
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202 358-1600



For Release

Donald L. Savage  
Headquarters, Washington, D.C.  
(Phone: 202/358-1547)

August 1, 1994

Keith Kohler  
Wallops Flight Facility, Wallops Island, Va.  
(Phone: 804/824-1579)

RELEASE: 94-126

## **NASA SOUNDING ROCKET CAMPAIGN TO STUDY IONOSPHERE WITH BRAZIL**

NASA will conduct with Brazilian space agencies a joint campaign to study the Earth's space environment over the magnetic equator from August 15 through October 20, 1994.

During the campaign, the NASA Goddard Space Flight Center's (GSFC) Wallops Flight Facility (WFF), Wallops Island, Va., will launch 33 rockets from the Centro de Lancamento de Alcantara launch range in the northeastern state of Maranhao, Brazil.

The campaign will help scientists better understand the unique properties of the Earth's ionosphere at the equator and is an integral part of the International Equatorial Electrojet Year. The project has been named the Guara Campaign after a beautiful species of bird native to the equatorial region of Brazil.

The ionosphere interests scientists because it acts like a mirror, reflecting high frequency radio waves, carrying currents that affect power systems on the ground and disturbing satellite transmissions that must pass through it.

According to the NASA campaign scientist, Dr. Robert Pfaff Jr., from GSFC in Greenbelt, Md., the Earth's magnetic field lines, which are parallel to the Earth's surface at the equator, affect the physics and electrodynamics of the equatorial ionosphere. This creates a variety of natural phenomena, including spectacular "eruptions" and turbulence in space, as well as intense currents or "electrojets."

The location where the field lines are exactly horizontal to the Earth is known as the magnetic equator. The Alcantara launch range is within one degree of the magnetic equator.

- more -

The sounding rocket campaign will investigate the electrodynamics and irregularities in the ionosphere and mesosphere along the magnetic equator and will study their relationship with the neutral atmosphere and winds. The sounding rocket experiments primarily will measure electric fields, currents, electron densities, neutral winds and ionospheric instabilities.

Suborbital sounding rockets provide the only means possible to take direct measurements in some regions of the Earth's atmosphere. The sounding rocket experiments during the Brazilian campaign require simultaneous measurements taken by ground-based scientific instruments, including backscatter radar, magnetometers and ionosondes. These instruments will be provided by scientists from the Brazilian Space Agency, Instituto Nacional de Pesquisas Espaciais (INPE).

More than 50 U.S. and Brazilian scientists will participate in the Guara campaign, supported by teams of approximately 300 engineers, technicians and staff.

NASA plans to fly a Brazilian science experiment as part of one of the payloads. The Brazilian scientific participation is coordinated by the INPE. Both sides will share the data from the rocket-borne and ground-based instruments. The Commission for Space Activities of the Federative Republic of Brazil (COBAE) will provide launch support services to NASA.

The rockets are divided among four experimental groups.

Between August 15 and 27, four Nike-Orion sounding rockets and 20 Viper 3A small meteorological rockets will be launched. The payloads will explore the interactions between small-scale turbulence and large-scale tidal motions and waves in the middle atmosphere at the magnetic equator. The Principal Investigator (PI) for the Nike-Orion experiments is Dr. Richard Goldberg from GSFC, and the PI for the Viper rockets is Frank Schmidlin from the WFF.

From September 1 through 20, four Black Brant VC sounding rockets will be launched during daytime, sunset and nighttime conditions carrying experiments to study the equatorial electrojet. The electrojet is an intense current of electrons that forms a corridor about one degree wide, encircling the Earth precisely along the magnetic equator at about 60 to 70 miles (96 to 112 kilometers) altitude. The payloads will measure, for the first time, the polarization electric fields that drive the electrojet current, as well as the current density itself. The PI is Dr. Robert Pfaff.

Four Nike-Tomahawk sounding rockets will be launched between September 21 and October 6. These experiments include a series of barium and trimethyl aluminum chemical releases near 127 miles (205 kilometers) altitude to study the winds and associated electric fields in the ionosphere at sunset.

- 3 -

The chemical trails are studied using photographs taken on the ground as well as on board a NASA airplane. The PI is Dr. Miguel Larsen from Clemson University in South Carolina.

The final launch will be a Black Brant X sounding rocket carrying experiments to measure the density and electric field turbulence associated with large depletions (or bubbles) that occur in the ionosphere at night along the Earth's magnetic equator. This payload includes the Brazilian experiment to measure plasma density. The PI is Dr. Jim LaBelle from Dartmouth College, Hanover, N.H.

NASA has conducted nine previous equatorial sounding rocket campaigns since 1964 from South America, Asia, Africa and the southern Pacific Ocean. These campaigns have included launching 97 suborbital rockets.

The WFF manages the NASA Sounding Rocket Program for the Office of Space Science, NASA Headquarters, Washington, D.C. The program conducts an average of 30 missions annually from sites worldwide.

- end -



August 3, 1994

Reply to Attn of:

**Memorandum for the Record**

Current News

Public Affairs Office, NASA Headquarters maintains a clipping file of major newspapers for only three years, and in some cases it may retain them for four years. After that time period they are tossed out. Not retired to the Federal Records Center, as they are not considered record material.

Consequently, the file of Current News in the History Office Documents Collection may well be the only extant copy around.

Headquarters News Releases

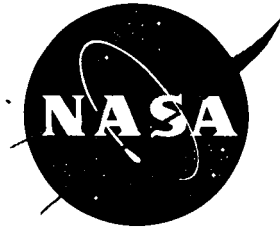
Public Affairs Office, NASA Headquarters has gone on-line with INTERNET and others for the distribution of News Releases. However, there will still be paper copies made available in the Headquarters Building for pickup. Today, I picked up two releases dated August 1, 1994. Additionally, "CASI" will still microfiche the news releases as they have in the past. The Headquarters History Office is on distribution to receive these microfiches.

  
Lee D. Saegesser  
NASA Archivist

# NASA News

National Aeronautics and  
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202 358-1600



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For Release

Don Savage  
Headquarters, Washington, D.C.  
(Phone: 202/358-1547)

August 3, 1994

Ann Hutchison  
Ames Research Center, Mountain View, Calif.  
(Phone: 415/604-9000)

RELEASE: C94-bb

## **NSI SERVICES TO PROVIDE TECHNICAL SUPPORT AT AMES**

NASA has selected NSI Technology Services of Sunnyvale, Calif., for negotiations leading to the award of a contract to provide engineering, technical, logistical and administrative technical services to support two airborne science aircraft at NASA's Ames Research Center, Mountain View, California.

The cost-plus-award-fee contract is valued at about \$29 million. The five-year contract includes a three-year base period followed by two one-year priced options. It also includes options for additional level of effort, materials and subcontracted services, and for expedition support for increased capability.

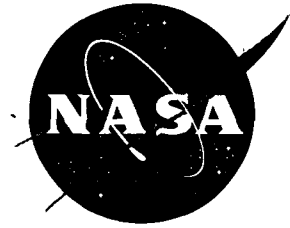
NSI Technology Services will provide support for the operation and maintenance, and continual development of, the C-141 Kuiper Airborne Observatory for Ames' Airborne Astronomy Missions Branch and the DC-8 data acquisition and distribution system for the Medium Altitude Mission Branch.

- end -

# NASA News

National Aeronautics and  
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202 358-1600



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For Release

Laurie Boeder  
Headquarters, Washington, D.C.  
(Phone: 202/358-1600)

August 3, 1994

RELEASE: 94-127

## **GOLDIN HAILS SOLID SENATE VOTE ON SPACE STATION**

NASA Administrator Daniel S. Goldin issued the following statement in response to today's U.S. Senate vote on an amendment to terminate funding for the international Space Station. The amendment, offered by Senator Dale Bumpers (D-AR), failed 64-36.

"The Senate cast a vote of confidence in America's space program, a vote for investment in our nation's future, and a vote for continued U.S. leadership in technology and exploration for decades to come.

"President Clinton's leadership, vision and commitment carried the day, and Vice President Gore's tireless advocacy was crucial to our success. The Space Station drew together a bipartisan coalition of support with senators on both sides of the aisle, recognizing that the Station is the next bold achievement for humanity in the exploration of space.

"The Space Station is a truly international scientific effort, and a powerful symbol of peaceful cooperation in the post Cold War world. Our new partnership with Russia gives us a bigger, more powerful, more capable space station, and strengthens the international partnership with Canada, Japan, and our European allies.

"The Space Station is no longer just a design or a dream. We are building hardware. We have a stronger program, with a restructured management team dedicated to keeping the program on track, on budget, and on schedule. It is part of NASA's balanced program of human space flight, robotic spacecraft, and a strong aeronautics program to deliver cutting-edge science and technology to the American people."

- end -

# NASA News

National Aeronautics and  
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202 358-1600



For Release

Donald L. Savage  
Headquarters, Washington, D.C.  
(Phone: 202/358-1547)

August 3, 1994

RELEASE: 94-128

## **NASA APPOINTS NEAR-EARTH OBJECT SEARCH COMMITTEE**

NASA today announced the establishment of a committee that will develop a plan to identify and catalogue, to the extent practicable within 10 years, all comets and asteroids which may threaten Earth.

Dr. Eugene Shoemaker was appointed as Chairman of the eight-member Near-Earth Object Search Committee. Shoemaker, an astronomer with the Lowell Observatory and professor emeritus with the U.S. Geological Survey, also was co-discoverer of Comet Shoemaker-Levy 9 which collided with Jupiter last month.

The committee was formed in response to Congressional direction to NASA to develop a plan in coordination with the Department of Defense and the space agencies of other countries. The plan's objective is to identify and catalogue, to the extent practicable, the orbital characteristics of all comets and asteroids greater than about 1/2 mile (1 kilometer) in diameter in orbit around the Sun that cross the orbit of the Earth. The plan is to include estimated budgetary requirements for fiscal years 1996 through 2000.

The House Committee on Science, Space and Technology amended the NASA Authorization bill to require the NASA Administrator to submit the plan to the Congress by Feb. 1, 1995. Also appointed to the committee are:

Dr. Jurgen H. Rahe, Executive Secretary, NASA Headquarters, Wash., D.C.  
Dr. Gregory Canavan, Dept. of Energy Los Alamos National Laboratory, N.M.  
Dr. Alan J. Harris, NASA Jet Propulsion Laboratory, Pasadena, Calif.  
Dr. David Morrison, NASA Ames Research Center, Mountain View, Calif.  
Dr. David L. Rabinowitz, Carnegie Institution, Wash., D.C.  
Dr. Michael J. Mumma, NASA Goddard Space Flight Center, Greenbelt, Md.  
Col. Simon P. Worden, U.S. Air Force Space Command, Colorado Springs, Colo.

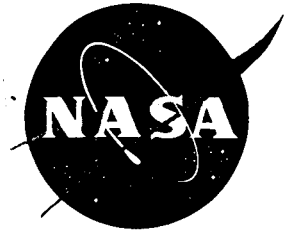
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NOTE TO EDITORS: Copies of the Jan. 25, 1992, report of the NASA International Near-Earth Detection Workshop called, "The Spaceguard Survey," are available to news media by faxing requests to the NASA Newsroom at 202/358-4210.

# NASA News

National Aeronautics and  
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202 358-1600



For Release

Ed Campion  
Headquarters, Washington, D.C.  
(Phone: 202/358-1778)

August 4, 1994

Kyle Herring  
Johnson Space Center, Houston  
(Phone: 713/483-5111)

RELEASE: 94-129

## **ASTRONAUT GUTIERREZ LEAVES NASA, AIR FORCE**

Astronaut Sidney M. Gutierrez (Colonel, USAF) will leave NASA effective August 8 and retire from the Air Force to join Sandia National Laboratories located in his hometown of Albuquerque, N.M.

At Sandia National Laboratories, he will be the Manager for Strategic Planning and Development. His retirement from the Air Force is effective October 1.

A member of the astronaut class of 1984, Gutierrez has flown twice on the Space Shuttle, most recently in April as Commander of Endeavour's STS-59 mission that used sophisticated radar equipment to map the Earth's surface, measuring environmental changes and atmospheric pollution.

His first mission in June 1991 aboard Columbia on the STS-40 mission was dedicated to the study of the human body on the first Spacelab Life Sciences flight. Between his first and second flights, Gutierrez worked in the Mission Control Center (MCC) as the communications link between the MCC and the Shuttle and served as Chief of the Operations Development Branch in the Astronaut Office.

"Sid has been a valuable asset to this Agency," said David C. Leestma, Director of Flight Crew Operations at the Johnson Space Center. "His career here is a perfect example of how important a member of the astronaut corps is in preparing others for spaceflight as well as being a crew member."

-more-

-2-

Prior to his first mission, Gutierrez held various technical assignments at NASA including Shuttle flight software verification and development; recertification of the main engines, main propulsion system and external tank after the Challenger accident; and Action Officer at NASA Headquarters.

Gutierrez has logged more than 4,500 hours flying time in about 30 different types of aircraft, including the F-15, F-16, F-4 and T-38. He has accumulated 488 hours in space on two Shuttle missions.

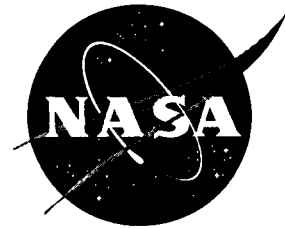
Born in Albuquerque, Gutierrez, 43, graduated from the Air Force Academy in 1973 with a Bachelor of Science degree in aeronautical engineering. He received his Masters degree in management from Webster College in Missouri in 1977.

- end -

# NASA News

National Aeronautics and  
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202 358-1600



For Release

Ed Campion  
Headquarters, Washington, D.C.  
(Phone: 202/358-1778)

August 8, 1994

Steve Nesbitt  
Johnson Space Center, Houston  
(Phone: 713/483-5111)

NOTE TO EDITORS: N94-59

## **STS-64/LITE MISSION PRE-FLIGHT BRIEFINGS SET FOR AUGUST 16**

Briefings to the news media on the experiments and activities associated with the September launch of Space Shuttle Discovery on the STS-64 mission will be conducted at 9:00 a. m. EDT on Tues., August 16, 1994. Briefings will take place from NASA's Johnson Space Center (JSC), Houston and the Goddard Space Flight Center (GSFC), Greenbelt, Md. The briefings will be carried live on NASA Television.

The primary payload for the STS-64 mission is the Lidar In-Space Technology Experiment (LITE), a technology demonstration payload which will beam narrow pulses of laser light through the atmosphere. LITE will use a telescope to measure the laser's light as it is reflected from clouds, from suspended particles in the air and from the Earth's surface. This is the first time this type of laser system has flown in space for atmospheric studies.

NASA Television can be accessed on Spacenet-2, Transponder 5, located at 69 degrees west longitude; frequency 3880.0 MHz, audio 6.8 MHz. There will be two-way Q&A capability for all briefings from NASA Headquarters and NASA field centers.

Attached is a list of the times and topics that will be covered during the briefings.

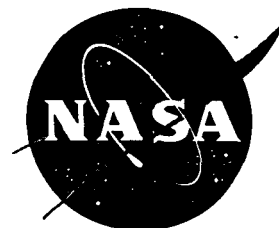
- end -

<b><u>Time (EDT)</u></b>	<b><u>Subject of Briefing</u></b>	<b><u>Location of Briefing</u></b>
9:00 a.m.	STS-64 Mission Overview	JSC
10:00 a.m.	Lidar In-Space Technology Experiment (LITE)	JSC
11:00 a.m.	Robot Operated Materials Processing System (ROMPS)	GSFC
11:30 a.m.	Shuttle Pointed Autonomous Research Tool for Astronomy (SPARTAN-201)	GSFC
Noon	Get Away Special (GAS)	GSFC
1:30 p.m.	Shuttle Plume Impingement Flight Experiment (SPIFEX)	JSC
2:00 p.m.	Simplified Aid for EVA Rescue (SAFER)	JSC
3:00 p.m.	STS-64 Crew Pre-Flight Press Conference	JSC

# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
202 358-1600



For Release

Barbara Selby  
Headquarters, Washington, D.C.  
(Phone: 202/358-1983)

August 8, 1994

Mary Ann Peto  
Lewis Research Center, Cleveland, Ohio  
(Phone: 216/433-2902)

Pat Lackner  
Ohio Aerospace Institute, Cleveland, Ohio  
(Phone: 216/962-3013)

RELEASE: 94-130

## **FORDYCE NAMED OHIO AEROSPACE INSTITUTE CHIEF SCIENTIST**

Dr. J. Stuart Fordyce, Deputy Director of NASA's Lewis Research Center, Cleveland, has been appointed Chief Scientist at the Ohio Aerospace Institute (OAI), Cleveland, effective September 18.

OAI is a private, non-profit consortium of nine Ohio universities, Lewis Research Center, Wright-Patterson Air Force Base and private companies. Established in 1989, the Institute is committed to enhancing Ohio and U.S. competitiveness through research, education and the adaptation of advanced technology.

In his new position, Fordyce will report directly to the Institute's President, Dr. Michael J. Salkind, and will work to develop opportunities for collaborative research projects, technology transfer initiatives and educational programs.

"Fordyce's impressive capabilities will help OAI build on its strengths in facilitating technology advancement," said Salkind. "In addition, his technical expertise will be a valuable resource for OAI's many diverse programs."

"Dr. Fordyce has made outstanding contributions to the nation's aerospace effort," added Dr. Wesley L. Harris, NASA Associate Administrator for Aeronautics. "He brings a wealth of experience and expertise to his new position."

-more-

Fordyce has served as Deputy Director of Lewis since 1991 and has shared responsibility for management of all the work carried out by the center. He joined Lewis in 1966 after eight years in private industry. Born in London, he received his A.B. degree from Dartmouth College and his Ph.D. in physical chemistry from the Massachusetts Institute of Technology.

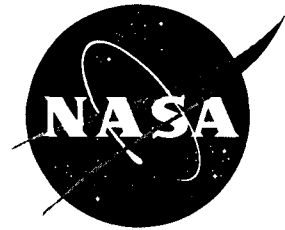
While at Lewis, Fordyce has held a series of managerial positions including: Director of Aerospace Technology; Chief, Space Power Technology Division; and Chief, Electrochemistry Branch. Over the years, he directed the center's efforts in aeropropulsion materials and structures; space power and propulsion; communications and advanced electronics technologies; energy technology; and microgravity materials science. His technical career has been devoted to advancing energy conversion technologies. He is the author or co-author of more than 35 technical reports and articles.

Fordyce has received numerous awards including NASA's Exceptional Service Medal, Presidential Rank of Meritorious Executive and NASA's Medal for Outstanding Leadership. He is an Associate Fellow of the American Institute for Aeronautics and Astronautics and a member of many other professional organizations. Fordyce has been a special lecturer for the International Space University and was named as Distinguished Space Technology Lecturer by Columbia University. He is listed in "American Men and Women of Science" and "Who's Who in Government."

# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
202 358-1600



For Release

Barbara Selby  
Headquarters, Washington, D.C.  
(Phone: 202/358-1983)

August 8, 1994

RELEASE: 94-131

## **NASA STIMULATES USE OF SCIENCE DATA OVER THE INTERNET**

NASA today selected BDM Federal, Inc., McLean, Va., to form a Remote Sensing Public Access Center (RSPAC) for demonstrating, testing and transferring technology to help provide public use of Earth and space science data over the Internet.

The intent of the new center is to stimulate broad public use, via the Internet, of the very large remote sensing databases -- maintained by NASA and other agencies -- to stimulate U.S. economic growth, improve the quality of life and contribute to the implementation of a National Information Infrastructure.

"We are looking forward to working with BDM to assist the public in accessing and using NASA data," said Lee B. Holcomb, NASA's Director for High Performance Computing and Communications. "We envision that this center will play a key role in developing universal access to the products of NASA's Earth and space science research."

BDM will receive \$12.8 million under a cooperative agreement to establish the RSPAC, which will demonstrate, test and facilitate remote sensing database applications and new digital library technologies. BDM will be supported by West Virginia University Research Corp., Morgantown, and Jardon and Howard Technologies in Winter Park, Fla. The West Virginia University/NASA Independent Verification and Validation Facility in Fairmont, W.Va., will be the central site for RSPAC activities.

The center will extend access to remote sensing data beyond the usual scientific community. By providing Internet access and user help, remote sensing data now will be available to the educational community (from K-12 to the university level), television and print media, libraries and hobbyists. Because the data will be available over the Internet, non-traditional users will have much greater ease of access than in the past.

- end -

# NASA News

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202 358-1600



For Release

Brian Dunbar  
Headquarters, Washington, D.C.  
(Phone: 202/358-1547)

August 10, 1994

Release: 94-132

## **FRENCH SPACE AGENCY HONORS TOPEX-POSEIDON TEAM**

The French space agency honored members of the U.S.-French TOPEX/POSEIDON management team today by awarding them the CNES Medal in recognition of their achievements. The Centre Nationale d'Etudes Spatiales (CNES) awards the medal periodically in recognition of highly successful projects.

CNES General Director Jean-Daniel Levi presented the award to seven team members from NASA Headquarters, Washington, D.C.; NASA's Jet Propulsion Laboratory (JPL), Pasadena, Calif.; and the CNES project office. Receiving the award were:

- Dr. Lee-Leung Fu, JPL Project Scientist;
- W. Linwood Jones, NASA Kennedy Space Center, former NASA Program Manager;
- Dr. Michel Lefebvre, CNES Project Scientist;
- Dr. William Patzert, JPL, former Program Scientist;
- William Townsend, Deputy Associate Administrator, Office of Mission to Planet Earth, and former NASA Program Manager;
- Dr. W. Stanley Wilson, National Oceanic and Atmospheric Administration (NOAA) Assistant Administrator, National Ocean Service, former NASA Program Scientist; and
- Charles Yamarone, JPL Project Manager.

Launched August 10, 1992, TOPEX/POSEIDON is studying the topography of the oceans, providing scientists with the data they need to better understand how ocean circulation distributes heat around the Earth and how the oceans affect climate.

In two years, the satellite has completed 9,350 orbits and 69, ten-day science data-gathering cycles, collecting more than one trillion bits of data. The satellite is measuring sea level to an accuracy of 2.2 inches (5.7 centimeters), and the data have been distributed to the international science team for their analysis.

-more-

-2-

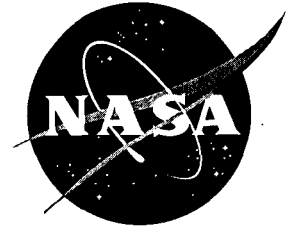
TOPEX/POSEIDON is the first mission to provide such precise and accurate observations of sea level, allowing scientists to study complex global ocean dynamics. Eventually, scientists will use the data to help them determine how ocean currents contribute to world-wide climate change.

- end -

# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
202 358-1600



Donald L. Savage  
Headquarters, Washington, D.C.  
(Phone: 202/358-1547)

For Release  
August 11, 1994

## **MEDIA ADVISORY**

### **NASA NAMES HUCKINS CASSINI PROGRAM DIRECTOR**

NASA today announced that Dr. Earle K. Huckins III has been appointed the Cassini Program Director in the Office of Space Science. In this position he will have overall responsibility for the Cassini Program and report directly to the Associate Administrator for Space Science.

Cassini is an international program to explore the planet Saturn, its rings and moons and the surrounding environment. Scheduled for launch on a Titan IV Centaur in October, 1997, from the Eastern Test Range in Florida, the Cassini spacecraft will swing by the planet Venus in April, 1998, and again in June, 1999. The spacecraft will swing by Earth in August, 1999, Jupiter in December, 2000, and will be inserted into a highly eccentric orbit around Saturn in June, 2004. The spacecraft will orbit Saturn for four years.

In the early part of the mission at Saturn, the Huygens Probe, provided by the European Space Agency (ESA), will enter and descend through the atmosphere of the moon Titan, gathering science data and attempting a landing on the surface.

The Cassini Project is managed by the Jet Propulsion Laboratory (JPL), Pasadena Calif. JPL is designing, building and integrating the spacecraft as an in-house project.

International partners in the mission are ESA and the Italian Space Agency (ASI). In addition, the Federal Republic of Germany and the United Kingdom are providing major science instruments and eight European countries are participating in instrumentation and science support. The ASI is a partner in the design and fabrication of the spacecraft orbiter, supplying the high gain antenna and other spacecraft systems and instruments, and ESA is providing the Huygens Probe. Each of the 18 science instruments has broad international participation.

- more -

NASA is procuring the Titan Centaur through the U. S. Air Force. Lewis Research Center, Cleveland, is managing the launch vehicle-to-spacecraft integration and launch support. The Department of Energy is providing the Radioisotope Thermoelectric Generators (RTGs) for spacecraft power, the Radioisotope Heater Units and supporting the launch approval process.

The new position of Cassini Program Director was established to more effectively focus senior management attention on the program-level international and interagency coordination required for launch and to assure mission success. Dr. Peter B. Ulrich, the Cassini Program Manager at NASA Headquarters, was recently selected as Chief, Flight Programs Branch in the Office of Space Science. This branch will continue to retain Cassini spacecraft management responsibility and function as the primary interface with the Cassini Project Office at JPL.

Dr. Huckins joined NASA in 1962 as a student trainee at NASA Langley Research Center, Hampton, Va. He specialized in the field of spacecraft dynamics, stability and control. Dr. Huckins held various management positions at Langley including Mission Integration Manager for the Long Duration Exposure Facility Project, Head of the Large Space Antenna Systems Technology Office, Manager of the Large Space Structures Technology Program, and Deputy Manager of the Space Station Evolutionary Definition Office.

In 1986, Dr. Huckins came to NASA Headquarters on a temporary assignment as Technical Assistant to the Associate Administrator for Space Station. Prior to his current assignment, he was Director of the Strategic Plans and Programs Division in the Office of Space Station; Director, Space Station Engineering, in the Office of Space Systems Development; and Chief Engineer in the Office of Space Flight.

Dr. Huckins received a B.S. in Aerospace Engineering from Virginia Polytechnic Institute in 1966, a Master of Mechanical Engineering from North Carolina State University in 1968, and a Ph.D in Aerospace Engineering from Virginia Polytechnic Institute and State University in 1972. He completed the Program for Management Development at Harvard University Graduate School of Business Administration under a NASA fellowship in 1984. Dr. Huckins has received a NASA Exceptional Service Medal, a Creative Management Award, and numerous Special Achievement Awards.

# NASA News

National Aeronautics and  
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202 358-1600



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For Release

Ann Hutchison (Primary)  
Ames Research Center, Moffett Field, Calif.  
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August 12, 1994

Barbara Selby (Back-up)  
Headquarters, Washington, D.C.  
(Phone: 202/358-1983)

RELEASE: C94-bb

## **I-NET AWARDED AMES RESEARCH CENTER CONTRACT**

NASA's Ames Research Center, Moffett Field, Calif., has awarded a contract to I-NET, Inc., Bethesda, Md., for an estimated \$42.3 million, including all options.

The contractor will provide information and communications support services for Ames. The one-year contract, which begins Sept. 1, 1994, has four additional one-year options.

- end-

# NASA News

National Aeronautics and  
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202 358-1600



For Release

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Headquarters, Washington, D.C.  
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August 12, 1994

James H. Wilson  
Jet Propulsion Laboratory, Pasadena, Calif.  
(Phone: 818/354-5011)

RELEASE: 94-133

## **GALILEO BEGINS SENDING SHOEMAKER-LEVY DATA**

NASA's Galileo spacecraft has begun a six-month process of radioing to Earth data taken during the collisions of Comet Shoemaker-Levy 9 at Jupiter in July.

From its vantage point in space en route to Jupiter, Galileo had the only direct view of the collisions of comet fragments on the dark side of the giant planet, July 16-22. Galileo stored observational data on its onboard tape recorder and is transmitting the data to Earth via its low-gain antenna over several months.

Ground controllers initially instructed Galileo to send back "jail-bar" image strips -- narrow slices of various portions of data -- to help them search for the most promising observations on the spacecraft's tape recorder. Preliminary looks at "jail-bar" data recently sent to Earth of the impact of the comet's fragment K led scientists to confirm detection of an intense burst of light lasting about 40 seconds.

These data are from a special time exposure frame that forms a streak from Jupiter and another from the impact flare, providing high resolution in time and brightness. More data from the K event will be sent to Earth in October.

Other data still stored on board the spacecraft include images of the fragment W impact. Mission scientists do not yet know whether the actual impact was captured on these frames. A small portion of the fragment W data will be sent to Earth in mid-August and late September and the rest is scheduled to be received in January.

Data from the fragment G impact were taken with Galileo's ultraviolet spectrometer, the infrared mapping spectrometer and the photopolarimeter. These data will be returned starting in late September and continuing through December.

- more -

- 2 -

Galileo data primarily of interest to scientists and amateur astronomers will be posted on an ongoing basis on the Internet via the World Wide Web system. This may be accessed by the public from the home page of NASA's Jet Propulsion Laboratory (JPL), Pasadena, Calif., at the address <http://www.jpl.nasa.gov/> under the "News" heading.

If comet impact images of more general interest are received, they will be released through the newsrooms at NASA Headquarters, Washington, D.C., and at JPL.

- end -

# NASA News

National Aeronautics and  
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202 358-1600



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For Release

Michael Braukus  
Headquarters, Washington, D.C.  
(Phone: 202/358-1979)

August 16, 1994

RELEASE: 94-134

## **NASA, NIH SIGN AGREEMENT ON BIOMEDICAL RESEARCH**

A unique process for growing tissue samples that could be used in AIDS research is about to be explored in depth by NASA and the National Institutes of Health (NIH).

The two agencies recently signed an agreement that will combine the unique talents and experience of both organizations by exploiting NASA's bioreactor technology to produce three-dimensional tissue cultures for laboratory research.

The goal of the agreement is to engineer a human lymph node model for AIDS research and then to extend the use of this technology to a broad spectrum of tissues available at the NIH. This collaborative effort will enable researchers to culture tissues previously deemed too complex for current tissue culturing technology .

Growing tissue samples under laboratory conditions—"tissue culturing"—is one of the basic tools of biomedical research. Researchers create specialized environments in laboratory vessels in order to grow or "culture" tissues for further study. For example, researchers might culture cancer tumors in the laboratory so that they can study the effects of anti-cancer drugs on the tumor.

Unfortunately, cells are highly sensitive to their growth environment and conventional tissue culturing techniques may not produce human tissue samples that closely resemble tissue structures found in the human body. As part of its ongoing program of research, NASA has developed an advanced cell culturing technology that produces improved tissue cultures that promise a superior three-dimensional structure.

-more-

"The NASA bioreactor is a very promising technology in tissue engineering," said Dr. Harry C. Holloway, Associate Administrator, NASA's Office of Life and Microgravity Sciences and Applications. "The primary thrust of this agreement will be the transfer of ground-based NASA bioreactor technology to NIH to support their cutting-edge research in complex tissue engineering."

This agreement will increase the capabilities of biomedical researchers throughout NIH by transferring NASA technology to NIH and establishing a center within the National Institute of Child Health and Human Development (NICHD). The center will teach this new technology to hundreds of neighboring NIH intramural laboratories that currently employ other tissue culture techniques as part of their ongoing research.

The total value of the NASA contribution is approximately \$4.8 million over four and a half years. NICHD, through its Laboratory of Theoretical and Physical Biology, will provide laboratory space, scientific expertise and access to the advanced three-dimensional tissue imaging facility.

Dr. Joshua Zimmerberg, chief of the NIH's Laboratory of Theoretical and Physical Biology, will direct the joint NASA/NIH biotechnology project .

- end -

# NASA News

National Aeronautics and  
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202 358-1600



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For Release

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NASA Headquarters  
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August 18, 1994

David Steitz  
NASA Headquarters  
(Phone: 202/358-1730)

NOTE TO EDITORS: N94-61

## **NASA DISCOVERY PROGRAM TO HOST SPACECRAFT TECHNOLOGY FAIR**

NASA's Office of Advanced Concepts and Technology (OACT) and the Office of Space Science will host the NASA Discovery Technology Fair Thursday, August 25, at the Gateway Marriott Hotel, Crystal City, Arlington, Va., from 8:30 a.m. to 5 p.m. EDT.

The Technology Fair is offered to potential participants in the Discovery Program and others to increase awareness of advanced technologies available for low-cost missions to be launched in the late 1990s. The fair will feature hardware and descriptions of technology from selected companies which bid for the NASA Small Spacecraft Technology Initiative (SSTI) program. These companies will display prototypes and working models of a variety of technological solutions to advanced spacecraft requirements.

In addition to the exhibits, there will be two brief presentations beginning at 8:30 a.m. on current advances in spacecraft technology presented by Samuel L. Venneri, Director of the Spacecraft and Remote Sensing Division of OACT, and Laurence Adams, Chairman of the National Research Panel on Small Spacecraft Technology.

Exhibitors at the technology fair will include: TRW; Jackson and Tull; Harris Corp.; SSG, Inc.; CTA; Martin Marietta; Worldview; K-T Tech. Inc.; OSC; Microwave Monolithics, Inc.; LeGarde, Inc.; ASIC; Motorola; Orion International; Hughes Santa Barbara Research; Delco Electronics; Odetics; HDOS; Spectrum Astro, Inc.; Southwest Research Institute; Boeing Defense & Space; McDonnell Douglas; Ball Aerospace; Fairchild Aerospace; Honeywell, Inc.; and Loral Federal Systems.

- end -

## DISCOVERY AO TECHNOLOGY FAIR

### EXHIBITORS AND TECHNOLOGIES TO BE DISPLAYED

<u>COMPANY</u>	<u>TECHNOLOGIES FOR DISPLAY</u>
TRW	Power - Lightweight solar arrays Thermal Management Sensors - Integrated Optics Coolers Controls - Micro-reaction wheels Precision and adaptive pointing Star Sensors Materials, Structure & Mechanisms - Electronics integration & packaging Composites structures Deployable antennas Communication & Data Systems - Solid state data storage (low power, Gigabit) "Wide temperature" electronics Operations - Fault protection On-board processing & data compression Imaging Technologies & Remote Sensing Advanced Electronics (Smart Struts) R300 Payload Processor Optical Pointing Assembly Wide Field of View Star Sensor AB600 Advanced Bus
Jackson and Tull	Flight Hardware Flight Software Ground Support Equipment
Harris Corporation	Advanced Telemetry Processing Small S-band Ground Terminals Ground System Network Management Image Processing
SSG, Inc.	Light Weight Optical Systems
CTA	Hardware - Micro Sat Spacecraft System Components

**Martin Marietta**

- Power - Lightweight hybrid solid state remote power controllers
  - Copper Indium Diselenide (CIS) photovoltaics
  - HiH2 common pressure vessel batteries
  - AstroEdge composite concentrator solar array
- Command & Data Handling - Composite avionics housing
  - Multi-functional serial I/O bus
  - Open Architecture integrated avionics
- Materials, Structures & Mechanism -
  - Shape memory mechanisms
  - Integrated multi-functional composite spacecraft structure
  - Thermally conductive composites
- Instruments - Gamma Ray Spectrometer
  - Imager for MESUR Pathfinder
  - Descent Imaging/Spectral Radiometer
  - Visible Infrared Scanning Radiometer

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 Worldview

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 Satellite Mockup showing Sensors Cable

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 K-T Tech Inc.

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 Image Processing  
 Image Enhancement  
 Application to Remote Sensing  
 Medical Images  
 Document Processing  
 Tech Transfer

## OSC

Systems Integration  
 Custom Analytical Instrumentation  
 Low-Cost Micro Spacecraft  
 Turn-Key Space Systems  
 Launch Vehicle Systems  
 Range of Attitude Control Technologies  
 Spacecraft Separation Systems  
 Deployable Mechanisms and Booms  
 DOS-based Spacecraft Operating System  
 Low Power UHF Transmitters; 9600 BPS  
 UHF Downlink  
 Low-Cost Spacecraft Ground Station  
 64 Megabytes On-board Spacecraft Memory  
 Lightweight, High Efficiency, Small  
 Volume Microwave Transmitters  
 L-Band Transmitters  
 S-Band Transmitters

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Microwave Monolithics, Inc.

Miniature, Custom BaAs MMIC  
 Components  
 Miniature, GaAs Monolithic Switch Matrix  
 (IF & RF)  
 High Efficiency, Solid State Power  
 Amplifier (PA)  
 Super Low Prime Power Low Noise  
 Amplifier (LNA)

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LeGarde, Inc.

Lightweight Deployable Structures for  
 Space  
 MIL-SPEC Electronics  
 Inflatable/Rigidizable Materials &  
 Processes

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ASIC

Space Power Systems  
 Solar Energy Applications  
 Satellite Solar Cells
 

- High Efficiency Cascade Multi-Junction Solar Cells
- High Efficiency GaAs Solar Cells
- High Efficiency Silicon Solar Cells

 Solar Array Panels

Motorola	IRIDIUM Spacecraft Mockup Low Cost Satellite Laser Communications Terminal Core computer card for commercial spacecraft central processor Smart Modem Subsystem (L band/K band) Low Cost miniature, high efficiency DC/DC converter Viceroy miniature GPS spaceborne receiver MROC broadband tuner/receiver on a chip from Motorola for spacecraft
Orion International	Lightweight Solar Arrays and Composite Structures
Hughes Santa Barbara Research	Imaging Spectrometer Thermal Emission Spectrometer Data Acquisition Board (VME) Sensor System Test Equipment & S/W IR Detector Arrays
Delco Electronics	Solid State Gyron Technology "Hemispherical Resonator Gyroscope"
Odetics	Solid-State Data Storage
Hughes Danbury Optical Systems	Miniature Star Trackers Hyperspectral Digital Imaging Active & Adaptive Optics Optical Coatings Miniature Visible Imagers
Spectrum Astro, Inc.	C&DH Subsystem <ul style="list-style-type: none"> <li>- Mass Memory Storage Devices</li> <li>- SCSI I/F Board</li> <li>- CPU Board</li> <li>- Single Board Telemetry Encoder</li> </ul> Power Subsystem <ul style="list-style-type: none"> <li>- Charge Control Unit</li> <li>- Peak Power Tracker</li> </ul> Electrical Ground Support Equipment <ul style="list-style-type: none"> <li>- Power Rack</li> <li>- RF Rack</li> </ul>

Southwest Research Institute	Ground Data Systems Miniaturized Sensors Programmable High Voltage Power Supplies Space Flight Computers Space Science Research Flexible Computer Configurations
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Boeing Defense & Space	Structures <ul style="list-style-type: none"> <li>- Antennas</li> <li>- Payload Adapter</li> <li>- Spacecraft Bus Structure</li> <li>- Metering Truss</li> </ul> Electrical Power <ul style="list-style-type: none"> <li>- Integrated Power Panel</li> <li>- Concentrator Solar Arrays</li> <li>- Thermal Control of Space Batteries</li> </ul> Data Bus <ul style="list-style-type: none"> <li>- Dual Speed I773</li> <li>- Fiber Optic Data Bus</li> </ul> Advanced Spacecraft Integration Lab (ASIL) Command & Telemetry Unit <ul style="list-style-type: none"> <li>- Ring Laser Gyro</li> <li>- Flight Computer</li> </ul>
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McDonnell Douglas	Rapid Avionics Software Phototyping Sensors Robotics for Lunar Mars Exploration
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Ball Corporation	Star Trackers Attitude Determination Precision Pointing Hardware Aerospace Mechanisms Cryogenic Cooling
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Fairchild Aerospace	Data Systems Flight Computers Solid State Recorders
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Honeywell, Inc.	Advanced Processing Miniaturized RLG IMU Fiber Optic Gyros Brouter - Comm/Processor Interface Card ERADS (Earth Referencing Attitude Determination System) Antenna Pointing & Tracking System
Loral Federal Systems	Radiation-Hardened QML Electronics & Systems - Space-Qualified 16 and 32-BIT Processors - Rad-Hard Memories (SRAM's) - ASIC and Foundry Services - Multi-Chip Packaging
<u>NASA CENTER</u>	<u>TECHNOLOGIES FOR DISPLAY</u>
NASA HQ (Code C)	Consultation and Advice concerning Building Technology Transfer & Commercialization into a Plan
GSFC	Fiber Optic Display Mongoose Processor Memory Module Reed Solomon Encoder Energy Conversion/Storage Acoustic-Optic Tunable Filter UN Mex. SEU-tolerant ASIC Data Compression Sensor/Imager SiC Mirror Coating Gyro-Less Fine Pointing
ARC	Operations/Telescience Control Interfaces (Butler Hine) Sensors/Fiber Optic Sensor for Experiments & Satellite Control Operations/Science Associate (PI-in-a-Box) Operations/Automated Telescope
JSC	Rapid Sequence Design & Validation Autonomous Rendezvous Small Digital Transceivers for Multiple Data Rates & Multiple Modulation Schemes

## LARC

Rainbow Wafer Active Materials  
 Cloud editing algorithms  
 On-orbit processing & data compression  
 Carbon-carbon processing  
 Gas Filer Correlation Radiometer  
 Coatings/films  
 Composite structures  
 Deployable antennas  
 Variable geometry truss as a sample acquisition device  
 Omni-vision lens  
 Tera-hertz detectors  
 Laser Sensing Technology  
 Systems Analysis

## JPL

Miniature On-Board Advanced Flight Computer  
 High Density Gigabit Non-Volatile Storage  
 Autonomous Star & Feature Tracking  
 Small Spacecraft Power Systems  
 JPL Flight System Testbed  
 JPL Project Design Center  
 Small Missions Telecommunications  
 Electric Propulsion for Small Spacecraft  
 Micro Sensors  
 Active Pixel Sensors  
 Flight System Autonomy  
 Advanced Technology for Operations  
 Signal Processing Testbed  
 Light Weight, Low Cost Cameras and Spectrometers

## SSC

Remote Sensing Applications

## LERC

On-Board Propulsion  
 Video Compression  
 Battery Technology  
 Solar Cell & Array  
 Power Management Architectures  
 Thermal Management for Dense Electronics

## MSFC

SBIR  
 Materials  
 Controls

94-135

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

# SPACE SHUTTLE MISSION

**STS-64**

**PRESS KIT  
SEPTEMBER 1994**



LIDAR IN-SPACE TECHNOLOGY EXPERIMENT (LITE)

## **PUBLIC AFFAIRS CONTACTS**

### **For Information on the Space Shuttle**

Ed Campion Headquarters, Wash., D.C.	Policy/Management	202/358-1778
James Hartsfield Johnson Space Center, Houston	Mission Operations Astronauts	713/483-5111
Bruce Buckingham Kennedy Space Center, Fla.	Launch Processing KSC Landing Information	407/867-2468
June Malone Marshall Space Flight Center, Huntsville, Ala.	External Tank/SRBs/SSMEs	205/544-0034
Don Haley Dryden Flight Research Center, Edwards, Calif.	DFRC Landing Information	805/258-3448

### **For Information on NASA-Sponsored STS-64 Experiments**

Brian Dunbar Headquarters, Wash., D.C.	LITE science	202/358-1547
Charles Redmond Headquarters, Wash., D.C.	LITE technology ROMPS	202/358-1757
Don Savage Headquarters, Wash., D.C.	SPARTAN-201	202/358-1547
James Hartsfield Johnson Space Center, Houston	SAFER, SPIFEX	713/483-5111
Tammy Jones Goddard Space Flight Center, Greenbelt, Md.	GAS Experiments	301/286-5566
Mike Braukus Headquarters, Wash., D.C.	BRIC, SSCE	202/358-1979
Terri Sindelar Hudkins Headquarters, Wash., D.C.	SAREX	202/358-1977

### **For Information on DOD-Sponsored STS-64 Experiments**

Dave Hess Johnson Space Center, Houston	AMOS, MAST, RME	713/483-3498
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## **LASER ATMOSPHERIC RESEARCH, ROBOTIC OPERATIONS AND UNTETHERED SPACEWALK HIGHLIGHT SHUTTLE MISSION STS-64**

NASA's fifth Shuttle flight of 1994 will include two firsts when the Orbiter Discovery and her six-person crew perform atmospheric research using a laser and conduct robotic processing of semiconductor materials during Shuttle Mission STS-64. The mission also will see the deployment and retrieval of a free flying astronomical observer and the first untethered spacewalk by astronauts in over ten years.

Leading the STS-64 crew will be Mission Commander Richard (Dick) N. Richards who will be making his fourth flight. Pilot for the mission is L. Blaine Hammond, Jr. who is making his second flight. The four mission specialists aboard Discovery are Jerry M. Linenger who will be making his first flight; Susan J. Helms who will be making her second flight; Carl J. Meade, who will be making his third flight; and Mark C. Lee, who will be making his third flight.

Launch of Discovery currently is scheduled for no earlier than September 9, 1994, at 4:30 p.m. EDT. The planned mission duration is 8 days, 20 hours, 11 minutes. An on-time launch on September 9 would produce a landing at 12:41 p.m. EDT on September 18, 1994 at the Kennedy Space Center's Shuttle Landing Facility.

The STS-64 mission will see the first flight of the Lidar In-Space Technology Experiment (LITE) payload. The LITE is primarily a technology test. Discovery will carry a laboratory laser into space, point it toward the Earth and beam narrow pulses of laser light through the atmosphere. The LITE will use a telescope to measure the laser's light as it is reflected from clouds, the suspended particles in the air and from the Earth's surface. This is the first time this type of laser system -- called a lidar -- has flown in space for atmospheric studies. Engineers will use information from LITE in the development of future remote-sensing instruments, including elements of NASA's Earth Observing System, a series of environmental satellites scheduled to begin launching in 1998.

The LITE will collect atmospheric data and will provide an opportunity to collect valuable information about the Earth's atmosphere -- crucial for a better understanding of our climate. Information gained from LITE can help explain the impact of human activity on the atmosphere as well as provide a new tool for improved measurements of clouds, particles in the atmosphere and the Earth's surface.

On the fifth day of the STS-64 mission, Helms will use the Shuttle's mechanical arm to deploy the Shuttle Pointed Autonomous Research Tool for Astronomy-201 (SPARTAN-201) payload. For 40 hours, Spartan-201 will fly free of the Shuttle and study the acceleration and velocity of the solar wind and measure aspects of the Sun's corona. The corona is difficult to study because it is so dim relative to the rest of the Sun. On Flight Day seven, the Shuttle will rendezvous with SPARTAN-201 after which it will be retrieved and stowed in Discovery's cargo bay for return to Earth.

Discovery's cargo bay also will carry the Robot Operated Processing System (ROMPS) payload which is the first U.S. robotics system to be used in space. ROMPS will advance microgravity processing by using a robot to transport a variety of semiconductors from the storage racks to halogen lamp furnaces where their crystal structures are reformed in heating and cooling cycles. The purpose of ROMPS is to utilize the microgravity environment to develop commercially valuable methods of processing semiconductor materials. Another objective of the ROMPS program is to advance automation and robotics for material processing in ways that can lower the costs of developing and manufacturing semiconductors.

STS-64 crew members Mark Lee and Carl Meade will perform a six-and-a-half hour spacewalk on flight day eight of the mission to evaluate the Simplified Aid For EVA Rescue (SAFER); several spacewalking tools; and an Electronic Cuff Checklist developed to allow spacewalkers greater and easier access to information. SAFER is a small, self-contained, propulsive backpack device that can provide free-flying mobility for a spacewalker in an emergency. It is designed for self-rescue use by a spacewalker in the event the Shuttle is unable or unavailable to retrieve a detached, drifting crew member. Examples of such times may include a mission where the Shuttle is docked to the Russian Mir space station or to the International Space Station.

The STS-64 mission will see the continuation of NASA's Get Away Special (GAS) experiments program. The project gives an individual a chance to perform experiments in space on a Shuttle mission. On STS-64, U.S. universities and high schools and several foreign countries are flying experiments.

The Shuttle Plume Impingement Flight Experiment (SPIFEX) payload will study the characteristics and behavior of exhaust plumes from Discovery's Reaction Control System (RCS) thrusters during the mission. SPIFEX, when picked up by Discovery's mechanical arm, is a 33-foot long extension for the arm with a package of instruments that will measure the near-field, transition and far-field effects of thruster plumes. The plume information gathered by the experiment will assist planners in understanding the potential effects of thruster plumes on large space structures, such as the Russian Space Agency's Mir Space Station, and the

International Space Station, during future Shuttle docking and rendezvous operations.

Research on the development and differentiation of a major food crop family that provides half of the world's calorie intake from plants, is the subject of the second Biological Research in Canisters (BRIC-2) experiment on STS-64. Microgravity research on orchard grass, which is part of the plant family that includes wheat, rice and corn, possibly will provide critical insights into the reproductive biology of the world's major food crops.

The Solid Surface Combustion Experiment (SSCE) being flown is a major study of how flames spread in a microgravity environment. Conducting the flame spreading experiment in microgravity removes buoyant air motion caused by gravity, commonly observed as "hot gases rising." Comparing microgravity results with test results obtained in normal gravity on Earth (1g) provides detailed information about how air motion affects flame spreading. The SSCE results will contribute to improvements in fire safety equipment and practices both on Earth and in spacecraft.

Three Department of Defense sponsored experiments will be flown during the STS-64 mission. The Air Force Maui Optical System (AMOS) is an electrical-optical facility on the Hawaiian island of Maui. The AMOS facility tracks the orbiter as it flies over the area and records signatures from thruster firings, water dumps or the phenomena of "Shuttle glow." The information obtained by AMOS is used to calibrate the infrared and optical sensors at the facility. The Military Applications of Ship Tracks (MAST) experiment on STS-64 is part of a five-year research program designed to characterize how effluents from ship stacks can affect cloud properties in the immediate vicinity. These effects are seen visually as a bright line in clouds corresponding to the track of the ship. The Radiation Monitoring Equipment-III (RME-III) measures ionizing radiation exposure to the crew within the orbiter cabin. RME-III measures gamma ray, electron, neutron and proton radiation and calculates in real time exposure in RADS-tissue equivalent. The hand-held instrument is stored in a middeck locker during flight except for when the crew activates it and replaces the memory module every two days.

The STS-64 crew will take on the role of teacher as they educate students in the United States and other countries about mission objectives. Using the Shuttle Amateur Radio Experiment-II (SAREX-II), astronauts aboard Discovery will discuss with students what it is like to live and work in space.

STS-64 will be the 19th flight of Space Shuttle Discovery and the 64th flight of the Space Shuttle System.

- end -

## **MEDIA SERVICES INFORMATION**

### **NASA Television Transmission**

NASA television is now available through a new satellite system. NASA programming can now be accessed on Spacenet-2, Transponder 5, located at 69 degrees West longitude; frequency 3880.0 MHz, audio 6.8 MHz.

The schedule for television transmissions from the orbiter and for mission briefings will be available during the mission at Kennedy Space Center, Fla; Marshall Space Flight Center, Huntsville, Ala.; Dryden Flight Research Center, Edwards, Calif.; Johnson Space Center, Houston and NASA Headquarters, Washington, D.C. The television schedule will be updated to reflect changes dictated by mission operations.

Television schedules also may be obtained by calling COMSTOR 713/483-5817. COMSTOR is a computer data base service requiring the use of a telephone modem. A voice update of the television schedule is updated daily at noon Eastern time.

### **Status Reports**

Status reports on countdown and mission progress, on-orbit activities and landing operations will be produced by the appropriate NASA newscenter.

### **Briefings**

A mission press briefing schedule will be issued prior to launch. During the mission, status briefings by a Flight Director or Mission Operations representative and when appropriate, representatives from the payload team, will occur at least once per day. The updated NASA television schedule will indicate when mission briefings are planned.

## **STS-64 QUICK LOOK**

**Launch Date/Site:** September 9, 1994/KSC Pad 39-B

**Launch Time:** 4:30 p.m. EDT

**Orbiter:** Discovery (OV-103) - 19th Flight

**Orbit/Inclination:** 140 nautical miles/57 degrees

**Mission Duration:** 8 days, 20 hours, 11 minutes

**Landing Time/Date:** 12:41 p.m. EDT September 18, 1994

**Primary Landing Site:** Kennedy Space Center, Fla.

**Abort Landing Sites:** Return to Launch Site - KSC, Fla.  
TransAtlantic Abort Landing - Zaragoza, Spain,  
Moron, Spain, Ben Guerir, Morocco  
Abort Once Around - White Sands Space Harbor,  
N.M.

**Crew:** Richard Richards, Commander (CDR)  
Blaine Hammond, Pilot (PLT)  
Jerry Linenger, Mission Specialist 1 (MS1)  
Susan Helms, Mission Specialist 2 (MS2)  
Carl Meade, Mission Specialist 3 (MS3)  
Mark Lee, Mission Specialist 4 (MS4)

**Cargo Bay Payloads:** Lidar in Space Technology Experiment (LITE)  
Shuttle Pointed Autonomous Research Tool for  
Astronomy (SPARTAN 201)  
Robotic Operated Materials Processing System  
(ROMPS)  
Get Away Special Bridge Assembly (GBA)  
Shuttle Plume Impingement Flight Experiment  
(SPIFEX)  
Simplified Aid for Extravehicular Activity Rescue  
(SAFER)

**Middeck Payloads:** Air Force Maui Optical Site (AMOS)  
Biological Research in Canisters (BRIC)  
Military Application of Ship Tracks (MAST)  
Radiation Monitoring Experiment-III (RME-III)  
Shuttle Amateur Radio Experiment-II (SAREX-II)  
Solid Surface Combustion Experiment (SSCE)

**Development Test Objectives/Detailed Supplementary Objectives:**

- DTO 301D: Ascent Structural Capability Evaluation
- DTO 305D: Ascent Compartment Venting Evaluation
- DTO 306D: Descent Compartment Venting Evaluation
- DTO 307D: Entry Structural Capability Evaluation
- DTO 312: External Tank Thermal Protection System Performance
- DTO 319D: Orbiter/Payload Acceleration and Acoustics Environment Data
- DTO 414: Auxiliary Power Unit Shutdown Test
- DTO 520: Edwards Lakebed Runway Bearing Strength and Rolling Friction
- DTO 521: Orbiter Drag Chute System Test
- DTO 524: Landing Gear Loads and Brake Stability Evaluation
- DTO 659: Extended Duration Orbiter Treadmill Evaluation
- DTO 664: Cabin Temperature Survey
- DTO 671: EVA Hardware for Future Scheduled EVA Missions
- DTO 672: EMU Electronic Cuff Checklist
- DTO 673: Extended Duration Orbiter Ergometer Evaluation
- DTO 674: Thermo-Electric Liquid Cooling System Evaluation
- DTO 700-5: Payload Bay Mounted Rendezvous Laser
- DTO 700-7: Orbiter Data for Real Time Navigation Evaluation
- DTO 805: Crosswind Landing Performance
- DTO 830: Shuttle Plume Impingement Flight Experiment
- DSO 482: Cardiac Rhythm Disturbances During Extravehicular Activity
- DSO 487: Immunological Assessment of Crewmembers
- DSO 489: EVA Dosimetry Evaluation
- DSO 491: Characterization of Microbial Transfer Among Crewmembers
- DSO 603: Orthostatic Function During Entry, Landing and Egress
- DSO 604: Visual-Vestibular Integration as a Function of Adaptation
- DSO 610: In-Flight Assessment of Renal Stone Risk
- DSO 612: Energy Utilization
- DSO 614: The Effect of Prolonged Space Flight on Head and Gaze Stability During Locomotion
- DSO 621: In-Flight Use of Florinef to Improve Orthostatic Intolerance Postflight
- DSO 624: Pre and Postflight Measurement of Cardiorespiratory Responses to Submaximal Exercise
- DSO 626: Cardiovascular and Cerebrovascular Responses to Standing Before and After Space Flight
- DSO 901: Documentary Television
- DSO 902: Documentary Motion Picture Photography
- DSO 903: Documentary Still Photography

## **SPACE SHUTTLE ABORT MODES**

Space Shuttle launch abort philosophy aims toward safe and intact recovery of the flight crew, Orbiter and its payload. Abort modes include:

\* **Abort-To-Orbit (ATO)** -- Partial loss of main engine thrust late enough to permit reaching a minimal 105-nautical mile orbit with orbital maneuvering system engines.

\* **Abort-Once-Around (AOA)** -- Earlier main engine shutdown with the capability to allow one orbit around before landing at White Sands Space Harbor, N.M.

\* **TransAtlantic Abort Landing (TAL)** -- Loss of one or more main engines midway through powered flight would force a landing at either Zaragoza, Spain; Moron, Spain; or Ben Guerir, Morocco.

\* **Return-To-Launch-Site (RTL)** -- Early shutdown of one or more engines, and without enough energy to reach Zaragoza, would result in a pitch around and thrust back toward KSC until within gliding distance of the Shuttle Landing Facility.

STS-64 contingency landing sites are the Kennedy Space Center, White Sands, Zaragoza, Moron and Ben Guerir.

## **STS-64 SUMMARY TIMELINE**

### **Flight Day One**

Ascent  
OMS-2 burn (140 n.m. x 140 n.m.)  
LITE activation  
SPARTAN/ROMPS activation  
RME activation  
LITE operations  
ROMPS operations  
GAS activation

### **Flight Day Two**

LITE operations  
RMS checkout  
SAREX activation  
SPIFEX unberth/activation  
SPIFEX operations

### **Flight Day Three**

SPIFEX operations  
LITE operations  
ROMPS operations (overnight)

### **Flight Day Four**

SPIFEX operations  
SPIFEX berth  
LITE operations  
SSCE operations  
LITE operations (overnight)

### **Flight Day Five**

SPARTAN 201 deploy  
ROMPS operations (overnight)  
LITE operations (overnight)

### **Flight Day Six**

EMU checkout  
SAFER checkout  
LITE operations

### **Flight Day Seven**

Depress cabin to 10.2 psi  
SPARTAN 201 rendezvous  
SPARTAN 201 retrieval  
SPARTAN 201 berth  
ROMPS operations (overnight)  
LITE operations (overnight)

**Flight Day Eight**

EVA preparation

EVA/SAFER operations

Repressurize cabin to 14.7 psi

LITE operations overnight

ROMPS operations overnight

**Flight Day Nine**

SPIFEX unberth/activation

SPIFEX operations

SPIFEX berth

FCS checkout

ROMPS operations (overnight)

**Flight Day Ten**

Payload deactivation

Cabin stow

Deorbit preparation

Entry

Landing

### **STS-64 VEHICLE AND PAYLOAD WEIGHTS**

<b>Vehicle/Payload</b>	<b>Pounds</b>
Orbiter (Discovery) empty and 3 SSMEs	173,852
Lidar in Space Technology Experiment	5,920
Robot Operated Materials Processing System	1,150
SPARTAN 201 (deployable)	2,840
SPARTAN 201 support equipment	2,409
Shuttle Plume Impingement Flight Experiment	772
Get-Away Specials and Bridge Assembly	5,000
Simplified Aid For EVA Rescue	269
Biological Research in Canisters	36
Military Applications of Ship Tracks	66
Radiation Monitoring Experiment	7
Shuttle Amateur Radio Experiment-II	35
Solid Surface Combustion Experiment	139
Detailed Supplementary/Test Objectives	184
Total Vehicle at SRB Ignition	4,503,199
Orbiter Landing Weight	210,916

### STS-64 Orbital Events Summary

EVENT	START TIME (dd/hh:mm:ss)	VELOCITY CHANGE (feet per second)	ORBIT (n.m.)
OMS-2	00/00:38:00	209 fps	140 x 140
Trim Burn 1	00/04:03:00	TBD	139 x 141
Trim Burn 2	00/04:48:00	TBD	140 x 141
Trim Burn 3	01/04:15:00	TBD	140 x 141
Trim Burn 4	01/17:02:00	TBD	140 x 141
Trim Burn 5	03/16:51:00	TBD	140 x 141
Trim Burn 6	03/17:37:00	TBD	140 x 141
SP201 Release	03/23:14:00	N/A	139 x141
Sep-1	03/23:20:00	1 fps	140 x140
Sep-2	03/23:42:00	2 fps	140 x140
Sep-3	04/00:04:00	3 fps	140 x140
NC-1	04:03:03:00	2.7 fps	140 x 140
NC-2	04/17:25:00	1.9 fps	140 x 140
NH-1	04/18:10:00	TBD	140 x 140
NC-3	05/02:29:00	TBD	140 x 140
NPC	05/16:04:00	2.1 fps	139 x 139
NC-4	05/17:26:00	5.7 fps	136 x 140
NH-2	05/18:11:00	TBD	136 x 140
NCC	05/19:29:00	TBD	138 x 140
TI	05/20:25:00	3.2 fps	138 x 140

<b>EVENT</b>	<b>START TIME</b> (dd/hh:mm:ss)	<b>VELOCITY CHANGE</b> (feet per second)	<b>ORBIT</b> (n.m.)
MC-1	05/20:45:00	TBD	138 x 140
MC-2	05:21:13:00	TBD	139 x 140
MC-3	05/21:23:00	TBD	139 x 140
MC-4	05/21:33:00	TBD	139 x 140
Manual phase	05/21:38:00	TBD	139 x 140
SP201 Grapple	05/22:28:00	N/A	139 x140
HITE	06:00:40:00	14.2 fps	131 x 139
CIRC	06/01:21:00	14.7 fps	131 x 132
Deorbit	08/19:14:00	229 fps	N/A
Touchdown	08/20:12:00	N/A	N/A

**NOTES:**

1. All maneuvers are recalculated in real time and the burn values are frequently updated during the mission. Also, some burns may not be needed and could be deleted in real time.

2. The trim burns are engine firings by Discovery to precisely set up observations by LITE.

3. From SP 201 release through grapple, the engine firings are for separation, station keeping and rendezvous with the SPARTAN. The final phase of rendezvous begins with the TI (Terminal Phase Initiation) burn and culminates in Commander Dick Richards manually flying Discovery to within 40 feet of SPARTAN for capture using the mechanical arm.

4. The HITE and CIRC burns are performed to circularize Discovery's orbit and improve landing opportunities.

## STS-64 CREW RESPONSIBILITIES

TASK/PAYLOAD	PRIMARY	BACKUPS/OTHERS
LITE	Lee	Meade, Richards
ROMPS	Helms	Hammond
SPARTAN 201	Meade	Helms
GAS Cans	Linenger	Meade
SPIFEX	Helms	Lee, Hammond
SAFER/EVA	Lee (EV1), Meade (EV2)	Linenger (IV)

### Middeck Payloads:

SSCE	Meade	Hammond
BRIC	Helms	Meade
SAREX	Richards	Hammond, Linenger
RME-III	Hammond	Linenger
AMOS	Hammond	Richards

### Detailed Supplementary/Test Objectives:

DTO 659 (treadmill)	Linenger	Richards, Hammond
DTO 664 (cabin temp.)	Hammond	Helms
DTO 671 (EVA tools)	Meade	Lee
DTO 672 (EMU elec.)	Meade	Lee
DTO 673 (rower eval.)	Hammond, Richards, Linenger, Helms	
DTO 674 (LES cooling)	Hammond	Richards
DSO 482 (EVA cardiac)	Lee	Meade
DSO 483 (back pain)	Hammond, Meade, Lee (Linenger-measurer)	
DSO 603C (orthostatic)	Meade	Helms, Linenger
DSO 624 (exercise)	Hammond	Richards, Linenger

### Other:

Photography/TV	Linenger	Hammond
In-Flight Maintenance	Hammond	Meade
Earth Observations	Hammond	Linenger
RMS	Helms, Meade	Lee
Medical	Linenger	Richards

## **Lidar In-Space Technology Experiment (LITE)**

### **LITE Quick-Look Facts**

- Experiment duration: Up to 46:15 hours of operation over nine-day mission;
- A technology test of first space-based lidar or "optical radar" for studying the atmosphere;
- Atmospheric measurements of clouds and airborne dust will be taken to demonstrate the LITE lidar system;
- International ground science team will take supporting measurements at approximately 50 ground sites in approximately 20 countries;
- Five international aircraft will fly underneath LITE making measurements over broad geographical regions, to include Europe, the Southwest United States, the Caribbean, South America and the South Atlantic;
- Technology goal: To test the ability of lidar technology to operate in space and to verify its usefulness in studying the Earth's atmosphere and climate change.

### **Summary**

**The LITE mission is primarily a technology test.** The Space Shuttle will carry a laboratory laser into space, point it toward the Earth and beam narrow pulses of laser light through the atmosphere. LITE will use a telescope to measure the laser's light as it is reflected from clouds, suspended particles in the air and from the Earth's surface. Project engineers will closely monitor the performance and health of LITE's hardware. This is the first time this type of laser system -- called a lidar -- has flown in space for atmospheric studies. Engineers will use information from LITE in the development of future remote-sensing instruments, including elements of NASA's Earth Observing System (EOS), a series of environmental satellites scheduled to begin launching in 1998.

**The LITE mission will collect atmospheric data.** LITE will provide an opportunity to collect valuable information about the Earth's atmosphere—crucial for a better understanding of our climate. Having this first lidar in space allows for rapid, efficient and accurate global coverage. During the nine days of the mission, more than 46 hours of information will be gathered. Information gained from LITE can help explain the impact of human activity on the atmosphere as well as provide a new tool for improved measurements of clouds, particles in the atmosphere and the Earth's surface.

**LITE will be supported by a worldwide science team.** This team's measurements are an essential part of the LITE experiment because they will confirm the measurements taken from space. Information from the LITE flyovers will be verified by comparing it to results from similar measurements using airborne and ground-based instruments at more than

50 sites around the world. These instruments will measure very nearly the same vertical columns of air, clouds, and suspended particles that LITE will examine from space.

## **Background**

Lidar is a remote sensing technique that can be used to study clouds and aerosols (suspended particles) in the atmosphere. By sending out short pulses of laser light and detecting the portion reflected back to the instrument by the atmosphere, the instrument can obtain very high vertical and horizontal resolution.

Researchers at NASA's Langley Research Center, in cooperation with NASA's offices of Advanced Concepts and Technologies and Mission to Planet Earth, have been developing lidar systems and techniques for more than two decades to address a wide variety of atmospheric remote sensing applications. This effort has resulted in the development and operation of a number of ground-based and airborne lidar systems.

NASA's Office of Advanced Concepts and Technology developed LITE as part of its initiative to explore applications of space-based lidar and to gain experience for future systems. NASA's Office of Mission to Planet Earth is supporting the data collection and development of the sensor as part of its exploration of new remote-sensing techniques for environmental studies.

The LITE mission is the first to use lasers in space for study of the Earth's atmospheric environment. Using the Space Shuttle as a platform, LITE will provide information to help us better understand our climate system. An important objective of the program is to validate the instrument design principles in such areas as laser performance, thermal control, and autonomous operations and to gain experience in commanding the instrument on orbit.

## **The LITE Mission**

The LITE instrument will be mounted to a pallet inside the open payload bay of Discovery, which will orbit "upside-down" (with the bay pointed toward Earth). Discovery will fly at a relatively low altitude (about 160 miles or 260 kilometers), so that each downward-pointing lidar pulse is dispersed as little as possible on its way down through the atmosphere.

Over its nine-day mission, LITE will collect atmospheric information during ten 4-1/2 hour sessions, for a total of 45 hours. In addition, five 15-minute "snapshots" will be performed over specific target sites. LITE's observing targets include clouds, particles in the atmosphere, the planetary boundary layer (where the atmosphere meets the Earth's surface), density and temperature in the upper atmosphere and the Earth's surface.

During those periods, the returning lidar signals collected by LITE's telescope will be converted to digital data, which will be stored on tape and simultaneously transmitted down to investigators on the ground.

At one point during the mission, the Shuttle will execute roll and pitch maneuvers to change the angle at which the lidar reflects off its targets below. These tests will be useful to engineers designing future lidar instruments that can scan from side to side or front to back instead of holding to a fixed, downward-looking point of view.

Space Shuttle Discovery, orbiting at an inclination of 57 degrees to the equator, will pass over 25,000 miles of the Earth's surface with each revolution. The LITE instrument will be able to collect data for a wide range of geographic and atmospheric settings, including remote areas like the open ocean, in a very short period of time.

### **Technological Focus**

Because LITE is the first mission of its kind, the primary focus of the mission is to test the technological hardware. Scientists and engineers want to verify that the entire system works as planned in orbit—for example, that the laser and telescope remain aligned, that the built-in cooling system can handle the heat produced by a powerful lidar instrument and that the signals and noises are measured as expected. The Space Shuttle is an ideal "platform" for conducting this kind of technology test. It provides the opportunity to fly a heavy, multi-purpose instrument without building a dedicated satellite. Once the practical utility of lidar in space is demonstrated, the lessons learned during the LITE mission can be applied to designing future, operational systems that are lighter in weight, use less spacecraft power and are more capable.

### **How Lidar Works**

Lidar, an acronym for "light detection and ranging," is similar to the radar commonly used to track everything from airplanes in flight to thunderstorms. It can be thought of as an "optical radar." Instead of bouncing radio waves off its target, lidar uses short pulses of laser light. Some of that light reflects off tiny particles in the atmosphere, called aerosols, then back to a telescope aligned with the laser. By precisely timing the lidar "echo," and by measuring how much laser light is received by the telescope, scientists can accurately determine the location, distribution and nature of the particles. The result is a revolutionary new tool for studying constituents in the atmosphere, from cloud droplets to industrial emissions, that are difficult to detect by other means.

### **How Lidars' Capabilities Will Be Improved From Space**

Most remote-sensing satellites, including the ones used to produce our daily weather forecasts, rely on passive sensing. They simply measure the amount of solar radiation—visible light or other wavelengths—reflected, not

emitted, back to the satellite from the atmosphere, clouds, oceans or solid land. Lidar, which uses a laser, is an active sensor. It provides better vertical resolution than passive sensors due to the short length of laser pulses and the use of more direct data-analysis methods.

A lidar also carries its own light source, allowing it to operate during orbital day or night. Passive instruments have restrictions on their sensing due to their reliance on an external source of light such as the Sun or Moon. Lidar can transmit light pulses continuously.

Lasers also produce a tight, coherent beam that spreads very little as it travels from its source, compared to ordinary light. From its orbital altitude, LITE's laser beam would spread to only about 975 feet (300 meters) wide at the surface -- almost the size of three football fields. This allows the LITE instrument to measure a very small, narrowly defined column of the atmosphere with each pulse. A space-based lidar offers another great advantage in its ability to penetrate thin or broken clouds to "see" through to the troposphere, the lower part of the atmosphere where weather systems form and where most satellite remote sensors have difficulty seeing.

From its vantage point above the atmosphere, LITE's extremely accurate laser will flash very short pulses of light directly downward, ten times every second. These pulses, lasting less than 30 billionths of a second each, will be in three wavelengths corresponding to ultraviolet, infrared and visible green light. Because the wavelengths are precisely known, and because LITE's telescope is designed to filter out other types of radiation, the signals returning to the Space Shuttle after reflecting off small airborne water or ice droplets and aerosols (suspended particles) are easy to identify. Timing the returned signal pinpoints the particle's altitude to within an accuracy of approximately 50 feet (15 meters).

### **Geographic Areas Studied**

LITE's science mission takes in a variety of phenomena in widespread geographic areas. Targets include the organization of clouds in the western Pacific, cloud decks off the coasts of California and Peru, smoke plumes from biomass fires in South America and Africa and the transport of desert dust from the Sahara. The science team will study lower-atmosphere aerosols over the Amazon rain forest, gravity waves over the Andes Mountains in South America, and the reflection properties of desert surfaces in the United States, Africa and China.

### **Coordinating Ground Truth Data With LITE's Data Taken From the Shuttle**

The LITE instrument will take up to five 15-minute "snapshots" over target areas selected for scientific interest or to support validation observations. Numerous airborne and ground-based lidars will make measurements at the same time under the path of the Shuttle. These

"ground-truth" data provide a standard against which LITE data can be compared for accuracy.

The ground-based and aircraft lidars will collect similar data to what the Shuttle is attempting but from a lower perspective. A lidar at the Langley Research Center in Hampton, Va., for example, will take upward-looking data at the exact time the Space Shuttle is passing overhead. Among the other "snapshot" targets are sites in Europe, Australia and the Sahara desert (to observe desert dust). This collection of ground-truth data will be performed jointly by five U.S., Canadian and European aircraft.

### **LITE's Potential Contribution to Atmospheric Science**

Eventually, lidar instruments could be flown on permanently orbiting satellites to provide continuous global data. While LITE will collect data on a wide range of aerosols, from dust particles in the stratosphere to cloud droplets, future lidar instruments could be tailored to specific purposes. While one instrument studied clouds, another could track urban smog or desert dust storms.

Perhaps the greatest value of early space-based lidars is the unprecedented accuracy with which they can measure clouds on a global scale. Information on clouds is critical to improving computer models of global climate. Current remote-sensing satellites leave large gaps in our understanding of how clouds reflect and absorb solar energy, and how heat and moisture are exchanged between the air, ocean and land. Only by gathering more accurate information can scientists improve their models to the point where they can confidently predict the behavior of the real atmosphere, and tell how the environment is being affected by human activity.

### **Management**

The LITE payload is the culmination of the cooperative efforts of NASA Headquarters, several NASA centers and their support contractors. Langley Research Center provided overall project management for the design and development of the LITE instrument; Marshall Space Flight Center, Huntsville, Ala., provided the Spacelab Enhanced MDM Pallet (EMP) and High Data Rate Recorder; Johnson Space Center, Houston, Texas, provided overall mission management as well as the OASIS-1 and the interface hardware between the EMP and the experiment; and Goddard Space Flight Center, Greenbelt, Md., and Kennedy Space Center, Cape Canaveral, Fla., provided test integration facilities and personnel.

Overall LITE program management and funding are provided by NASA Headquarters through the offices of Advanced Concepts and Technology, Life and Microgravity Sciences and Applications and Mission to Planet Earth.

## **LITE INSTRUMENT**

The LITE payload was built at NASA's Langley Research Center, Hampton, Va. Langley has provided overall project management for the design and development of LITE's lidar instrument. Langley also will put the scientific data into usable form and make it available to scientists for their own studies.

### **Receiver Assembly**

The receiver includes a one-meter telescope (approximately 3.25 feet) and an aft optics package. The telescope collects laser light reflected from the atmosphere and brings it to focus in the aft optics. The aft optics will separate the return signal into its three color components. The 532 nanometer (visible green) and 355 nanometer (ultraviolet) detectors are photomultiplier tubes, while the 1064 nanometer (infrared) detector is a silicon avalanche photodiode.

An existing NASA telescope, which was an engineering model of the Orbiting Astronomical Observatory from Goddard Space Flight Center that flew in 1968, will be used as the lidar receiver. The use of this existing hardware will save NASA an estimated \$8 million.

### **Boresight Assembly**

The boresight assembly consists of a two-axis motor-driven prism. Its purpose is to align the laser beam to the telescope field-of-view so that both point to the same column of atmosphere.

### **Laser Transmitter Module (LTM)**

The LTM consists of two flash lamp-pumped, Q-switched Neodymium YAG lasers which emit simultaneously at the three harmonically related wavelengths of 1064 nanometers, 532 nanometers, and 355 nanometers. The two-laser system provides redundancy in case one laser fails. Only one laser operates at a time.

### **Support Instrumentation**

#### **OASIS-1 recorder**

The OASIS-1 will measure and internally record accelerations, acoustic loads, strains temperatures, thermal flux and pressures during the launch, ascent, on orbit, descent, and landing phases of the LITE mission.

## **Camera Assembly**

A special modified 35-mm camera will photograph daytime cloud cover and ground tracks every 20 seconds to help interpret the lidar data.

## **Experimental Platform**

The LITE instrument is mounted on an orthogrid platform which is attached to the Spacelab pallet by 52 struts. The orthogrid is a support platform for the instrument subsystems and is designed to be immune to thermal deformations which could affect optical alignment.

## **Instrument Controller**

The Instrument Controller handles all command and data interfaces of the LITE instrument. All subsystems can be commanded and controlled via the controller. Health and status of the LITE instrument are monitored and transferred to the Spacelab's Smart Flexible Multiplexer/Demultiplexer. The controller software consists of over 18 real-time tasks that perform all commands and data interfaces for the controller as well as independent operations.

## **Note to Amateur Astronomers**

The LITE payload will transmit a laser beam directly from the Space Shuttle payload bay to the Earth's surface. Using criteria provided by the American National Standards Institute (ANSI) on the safe use of lasers, NASA calculated the amount of laser-generated energy that might reach the ground and compared it to ANSI-determined safe levels of exposures.

The study found that observers attempting to view the Shuttle with the naked eye are not at risk of eye injury, nor are observers using ordinary binoculars or small telescopes (up to approximately six inches in diameter). However, there is a remote possibility that telescopes larger than six inches in diameter could collect enough energy to expose the observer to levels higher than ANSI's Maximum Permissible Exposure for one of the laser's three wavelengths (532 nanometers). Therefore, **observers should not attempt to view the Shuttle through telescopes larger than six inches.**

Capturing images electronically does not present a hazard to the observer, but highly sensitive photo-electronic detectors could possibly be damaged.

## **SPARTAN-201**

The Spartan program is designed to provide easy access to Earth orbit via the Space Shuttle for flying science experiments. Spartan uses proven technologies to provide a relatively inexpensive route to space for the scientific community. This is done by using a basic carrier which, with the addition of a science experiment, becomes a complete spacecraft capable of fulfilling the science objectives of each mission. Spartan missions can support stellar, solar, or Earth fine-pointing experiments, experiments requiring microgravity and experiments requiring space environments away from the Space Shuttle.

The Spartan project is managed by the Goddard Space Flight Center for the Office of Space Science, Washington, D.C. The Spartan Project Manager is Frank Collins; Goddard Space Flight Center Mission Manager is Craig Tooley; Goddard Principal Investigator is Dr. Richard Fisher and Dr. John Kohl is from the Smithsonian Astrophysical Observatory, Cambridge, Mass.

Spartan-201 will study the acceleration and velocity of the solar wind and measure aspects of the Sun's corona. Results should suggest solutions to the questions of coronal and solar wind physics with dramatic observations.

Spartan-201 is an orbiting spacecraft that is deployed by the Space Shuttle and retrieved on the same mission. After deployment, it is completely autonomous, providing its own battery power, pointing system and recorder for capturing data. While on orbit, Spartan executes a pre-programmed science mission.

The Spartan program has evolved using sounding rocket-class instruments to perform the scientific studies. This carrier system provides a significant increase in observing time compared to sounding rockets. The Spartan carriers are reusable and can accommodate a variety of scientific instruments on a low-cost per flight basis.

### **Spartan-201 Science**

The Spartan-201 will look for evidence to explain how the solar wind is generated by the Sun. The solar atmosphere constantly ejects electrons, protons and heavy ions from the outer layer, continuously impacting the Earth. The solar wind fills interplanetary space and sweeps by the Earth at nearly one million miles per hour (1.6 million km/hour). The wind often gusts, transmitting disturbances from the Sun that frequently disrupt navigation, communications and electric power distribution systems on Earth.

The solar wind originates in the corona, the outermost atmosphere of the Sun. Spartan-201 carries two separate telescopes to study the corona. One telescope, the White Light Coronagraph (WLC), measures the density distribution of electrons making up the corona. The other telescope, the

Ultraviolet Coronal Spectrometer (UVCS), investigates the temperatures and distributions of protons and hydrogen atoms through the same layers of the corona.

The corona is difficult to study in view of its relatively dim light in comparison to the Sun's total luminance. The white light corona can be viewed from Earth only during times of solar eclipse, which strongly reduces the brightness of the scattered sunlight. The ultraviolet radiation is never available to ground-based astronomers.

A comparison of the white light and ultraviolet data sets allows scientists to measure the electron and proton temperatures and densities in the solar corona and yields new evidence on bulk flows in the corona. These data sets also permit scientists to test specific theories on how the corona is heated to its million-degree temperature.

The scientific observations will be recorded on board Spartan-201 and analyzed by scientists and engineers after recovery on the ground. The Spartan carrier and instrument will be reflown on STS-72 in June 1995. This flight is timed to coincide with the Ulysses spacecraft passage over the north pole of the Sun.

The UVCS telescope was built by scientists from the Smithsonian Astrophysical Observatory, Cambridge, Mass. The WLC telescope was developed by the High Altitude Observatory of the National Center for Atmospheric Research in Boulder, Colo., and is maintained and managed by the Goddard Space Flight Center where the Spartan carrier structure was built. After the individual elements of the Spartan system are developed and completed by the respective investigator, the experiments are checked by engineers at Goddard. Finally, Goddard engineers integrate the payloads and perform system checks.

## **Deployment**

The dual-telescope science payload is mounted aboard the Spartan carrier. When the Shuttle is on orbit and the payload bay doors are open, a crew member uses the robot arm to lift Spartan from the payload bay and release it over the side of the Shuttle. It is deployed from the Shuttle so that it can operate independently, turning and pointing at the Sun, while leaving the orbiter free for other activities. Additionally, because the Spartan and Shuttle become separated, the Spartan is able to view the Sun clear of any contamination which might be generated by Shuttle thruster firings.

Spartan is designed to self-operate as much as possible. The Shuttle crew has little interaction with the satellite other than releasing it and recapturing it.

For approximately 40 hours, Spartan-201's instruments observe the Sun as the Space Shuttle paces it from behind. About four hours prior to the scheduled retrieval, the Shuttle performs engine firings allowing it to close on Spartan-201, eventually passing directly below it before a crew member manually flies the final few hundred feet (approximately 100 meters) to allow the satellite to be grasped by the robot arm. Once caught by the arm, Spartan-201 is stowed back in the cargo bay to be returned to Earth.

## **History**

The Spartan program was conceived in the mid-1970s and developed by the Special Payloads Division, Goddard Space Flight Center, and the U.S. Naval Research Laboratory, Washington, D.C., to extend the capabilities of sounding rocket-class science experiments by making use of the Space Shuttle.

The telescopes on Spartan-201 have flown three times previously on sounding rockets. In June 1985, a Spartan mission successfully carried an x-ray telescope aboard STS-51G. Another carrier, Spartan Halley, was on board Shuttle Mission STS-51L. In April 1993, Spartan-201 was flown aboard the Space Shuttle Discovery on mission STS-56.

## **Spartan-201 Statistics**

Launch Vehicle:	Space Shuttle Discovery
Deployment Altitude:	140 nautical miles
Inclination:	57 degrees
Spacecraft Weight:	2,840 lbs (1,288 kg)

## **ROMPS OVERVIEW**

The purpose of NASA's Robot Operated Materials Processing System (ROMPS) is to improve the properties of materials by processing them in space. The performance, and consequently the commercial value, of most semiconductor materials is highly dependent on their crystalline structure. Gravity driven convection and sedimentation, which disturb crystal formation, can be eliminated in the microgravity environment of space.

ROMPS is the first U.S. robotics system to be used in space. ROMPS will advance microgravity processing by using a robot to transport each of a large variety of semiconductors from the storage racks to halogen lamp furnaces where their crystal structures are re-formed in heating and cooling cycles. ROMPS is contained in two Space Shuttle sidewall mounted Get Away Special (GAS) cans, one containing the robot, furnaces and samples; the other containing control electronics. The Hitchhiker avionics system provides ROMPS with power, ground commands and telemetry. The ROMPS samples will be analyzed on the ground after the Shuttle mission, and the results will be used to define materials and processing for planned reflights of ROMPS on future Shuttle missions.

ROMPS Mission Manager is Lloyd Purves, Goddard Space Flight Center; Principal Investigator is Dr. Tim Anderson, University of Florida; Principal Investigator is Dr. Eric Cole, George Mason University; Co-Principal Investigator is Kevin Jones, University of Florida. ROMPS is managed for NASA by the Goddard Space Flight Center, Greenbelt, Md.

### **ROMPS Summary**

The purpose of ROMPS is to utilize the microgravity environment to develop commercially valuable methods of processing semiconductor materials. Microgravity processing can reduce semiconductor crystal irregularities caused by convection and sedimentation. Microgravity also can improve crystal structure by permitting containerless processing. Improved crystal structure will increase the performance of many types of semiconductors. A long-term ROMPS objective is to develop microgravity-processed semiconductor devices with sufficient performance advantages so that they can be competitively produced in space. There is also a more immediate objective of using microgravity processing to better understand the behavior of semiconductor crystal structures. This better understanding can improve the quality of ground processed semiconductors.

Another objective of the ROMPS program is to advance automation and robotics for material processing in ways that can lower the costs of developing and manufacturing semiconductors. The added cost of operations in space creates a need for in-space materials processing to have more advanced automation and robotics than are normally considered for ground operations. For example, an efficient long term space facility for materials processing not only needs to have robotic materials processing,

but the assembly, servicing and upgrading of the facility also needs to be done by robotics. This higher level of automation and robotics needed for in-space materials processing can be applied to improve the operational efficiencies of ground based semiconductor laboratories and production facilities. The current robotic design of ROMPS permits it to address a variety of commercial objectives in materials processing and automation technology as summarized in Table 1.

**Table 1 ROMPS Technology and Commercial Objectives**

Exp. No.	Technology Area	Commercial Objective	Responsible Orgs./ Industry Partners
1	Closed Space Vapor Deposition of In As Hall Generators	Improved noise immunity and repeatability of Hall Effect devices	UF/ F.W. Bell
2	RTA of Ion Implanted and In-situ Doped ZnS ACTFEL Devices	Enhanced color and reduced power consumption by EL devices	UF/ Planar Systems
3	Impurity Induced Disorder in GaAs/InP Superlattices	Improved optoelectronic devices	UF/ Kopin, Spire
4	Solid and Liquid Phase Epitaxial Regrowth of Si <sub>x</sub> Ge <sub>x</sub> on Silicon	Improved high speed transistors and LED's	UF/ Texas Instruments
5	Deposition and Solidification of Photovoltaic Materials	Higher performance and lower cost solar cells	UF & GMU/ Photon Energy, Astropower
6	Robot and Furnace for Semiconductor Materials Processing	More advanced and commercially produced automation system for space and ground processing of semiconductor materials	GSFC & SpARC/ Zymark, Interface & Control Systems

## **Organization**

ROMPS is sponsored by the NASA Office of Advanced Concepts and Technology (OACT) as part of its mission to develop commercially relevant techniques for in-space materials processing. The ROMPS project is being carried out by the Goddard Space Flight Center (GSFC) and two NASA sponsored Centers for the Commercial Development of Space (CCDSs). The CCDSs are the Consortium for Commercial Crystal Growth at Clarkson University in Potsdam, New York, and the Space Automation and Robotics Center (SpARC) in Ann Arbor, Michigan.

GSFC is providing its experience with autonomous space flight technology, space robotics and the HH/GAS system. GSFC also is managing the project and developing the ROMPS mechanisms. The two CCDSs are supported by OACT and are contributing the technical expertise and commercial linkages they have in their respective areas of responsibility. SpARC is developing the ROMPS control system, and the Clarkson CCDS is leading the materials processing work. The bulk of the Clarkson CCDS work is being done by its University of Florida (UF) member. The George Mason University (GMU), Fairfax, Va., is a co-Principal Investigator with UF.

Industry interest in ROMPS is shown by nine industry partners identified in Table 1 teaming with the two CCDSs and GMU. Industry involvement with regard to materials being processed includes donation of samples and substrates, analyzing results, developing returned samples into commercial products and funding. SpARC is collaborating with two companies whose automation products are being used for ROMPS.

## **Design**

The ROMPS flight hardware will be contained in a pair of GAS Cans mounted on the HH-G Carrier. One GAS Can is designated the Processing Can and consists of a full size GAS Can with a five inch extension. This GAS Can will house the samples, sample storage racks, robot, two furnaces, and some electronics. A second, smaller GAS Can is called the System Controller Can and will house the control electronics and Hitchhiker interface. Each GAS can will be pressurized to one atmosphere using dry nitrogen.

The HH system will provide the ROMPS GAS Cans with power and ground links for telemetry and commands. The HH configuration allows ground monitoring and control of in-space processing, return of the samples to ground and reflight of the ROMPS system with new samples and modified processing capabilities.

The ROMPS furnaces have tungsten halogen lamps and elliptical reflectors. There are two identical furnaces to provide lamp redundancy, and they are mounted to the GAS Can lid. This configuration will

conductively couple to the radiator to reject the furnace power of potentially 250 watts. Each furnace is about 6.5 in. diameter x 8.0 in. long and weighs less than 5 lbs. The furnaces also provide a mechanical and electrical interface to the sample pallets. This mechanical interface, consisting of two tapered pins, serves to align a pallet with respect to the lamp focus. The electrical interface is for the calibration pallets which are equipped with sensors to measure lamp output.

Each sample pallet has a sample holder which is sealed so that samples can be heated to a vapor phase without causing contamination. Sample materials, substrates, environments inside sealed sample holders, processing times and temperatures can be varied for each sample, thus allowing a wide range of materials research to be conducted using the same equipment.

The ROMPS robot will transfer each of approximately 150 sample pallets from its storage location to a processing furnace and back to its storage location. The robot has three degrees of freedom and a gripper. The robot's three positional axes (elevation, azimuth, radial) and the gripper will be position-controlled and force limited. Each robot axis incorporates a brushless DC motor drive, incremental position encoder, brake, gearing, and end-of-travel monitors. The gripper is activated like the robot axes except that it does not have a brake because it is not back-driveable and its position is monitored using sensors. Only one motor at a time is powered during operation. Transfer time for each sample between the storage rack and furnace is less than two minutes. The robot will be unpowered and braked during heating cycles so as not to disturb the sample being processed.

The accuracy of the three positioning axes at the tool tip is  $\pm 0.020$  in. ROMPS can accommodate robot positioning inaccuracies of up to about  $\pm 0.200$  in., using a compliance device on the robot, guides and tapers on pallets and objects that the pallets contact. The robot will grip a support to provide extra stiffness during launch and descent. When in this position the robot harnessing also will be held taut for minimum vibration.

The robot support structure attaches to the GAS Can lid. The robot assembly lower plate, on which is mounted the majority of the GAS Can electronics, will be snubbed to the canister side walls. For heat transfer, the robot will conductively couple to the upper radiator lid and radiatively couple to the lid and GAS Can interior.

The processor GAS Can also contains electronics for power control, motor power and furnace control. The Power Controller interfaces with the Hitchhiker and the ROMPS subsystems. The Power Controller provides the first level of Hitchhiker to ROMPS power-line filters, the fusing for safety power distribution to ROMPS subsystems, and the power distribution for safety interlocks and experiment operation. The motor control provides the power for the servo motor and switching to direct this power to whichever one of the four motors is selected by the System Controller. The furnace

controller provides the power going to the furnace lamps and controls this power to a level specified by a digital input signal from the ROMPS System Controller.

The ROMPS System Controller in a separate half height GAS can interfaces with the HH avionics and controls all experiment operations. Control functions include robot servo control, furnace profile control, and command and telemetry formatting and control. The Systems Controller also monitors the sensors and the conditions of other subsystems, and it formats telemetry to provide housekeeping data to the ground station.

ROMPS will be commanded from the ground. The System Controller contains a predetermined program for autonomous experiment operation once initiated by the proper ground commands. The first part of this predetermined program is a power up sequence to test the experiment subsystems. Upon successful testing, the experiment will execute the preprogrammed sequence of experiment samples. The gripper will be positioned to take the appropriate sample from the storage rack and position it in the furnace. After the annealing process, the sample is returned to its position in the rack and the next sample will be processed.

To get the lowest possible microgravity levels, the samples will be processed during crew rest periods when Shuttle vibrations will be at a minimum. Because of the number of samples and the possibility of lengthy heating times for certain samples, it is expected that processing will extend over more than one crew rest period. Thus the stored processing sequence will have automatic shutdowns scheduled for the end of each crew rest period. Ground command will restart the processing at the beginning of the next crew rest period. This occurs until all samples have been processed.

Thus, the processing will be basically autonomous with ground control used to monitor progress and intervene if unexpected situations develop. The System Controller will monitor outputs from temperature, position, force, and current sensors, as well as telemeter them to the ground station. The System Controller will stop the experiment if it detects problems or receives a command from the ground operator. If anomalies occur, the ground crew will diagnose the problem, develop alternate procedures, send up new command sequences, and reinitiate processing.

## **GET AWAY SPECIALS**

NASA's Get Away Special (GAS) program is managed by the Goddard Space Flight Center, Greenbelt, Md. Charlie Knapp is NASA Technical Manager for all GAS payloads on this mission. Clarke Prouty is GAS Mission Manager.

GAS remains a viable avenue for individuals and organizations to conduct experiments in space. Prior to this flight, GAS has flown 107 payloads. On STS-64, U.S. universities and high schools and several foreign countries are flying experiments. Following is a brief description of each:

### **G-178**

Customer: Sierra College, Rocklin, Calif.

Customer: Dr. Kevin Ramirez

Payload Manager: Mike Dobeck

G-178 is from Sierra College. The objective of this experiment is to take ozone measurements of the Earth's upper atmosphere in the ultraviolet (UV) 200 nanometer to 400 nanometer spectral range using a Charge Coupled Device (CCD)-based spectrometer. A CCD photographic camera also will fly as part of the experiment and provide target verification for the spectrometer.

### **G-254**

Customer: The Kinkaid School, Houston, Texas and Utah State University, Logan, Utah

Customer: Glen A. Ballard

Payload Manager: Tumkur Raghuram

Since it flew the world's first ten Get Away Special (GAS) experiments in the first GAS payload aboard Columbia in 1982, Utah State University (USU) has maintained an academic program designed to allow many individual students and other educational organizations to participate in a GAS space engineering and microgravity science program. Under this program, the university has flown 22 student GAS experiments to date in canisters G-001, G-004, G-008, G-010 and G-518.

On the present mission, the four experiments described below are being flown in their own individual spacepaks, one of which is of a new aluminum Isogrid construction. In addition, the payload will contain popcorn kernels and radish seeds in separate ziplock bags as an experiment by Edith Bowen Elementary School located on the USU campus. After the flight, the students will pop and taste the popcorn. The radishes will be grown and compared with a similar sample maintained in 1 g. The purpose of this experiment is to foster interest in the space sciences among a younger generation.

**Spacepak 1: Distillation Experiment.** The objective of this experiment, which is a joint endeavor between the Kinkaid School and USU, is to separate a mixture of two common organic liquids, trichlorotrifluoroethane and chloroform, in microgravity by distillation. These liquids have boiling points of 47 degrees C (116 degrees F) and 61.2 degrees C (140 degrees F) respectively. An aluminum chamber containing the liquids will be heated to 53 degrees C (127 degrees F) after a solenoid opens a ball valve connecting the chamber to another aluminum collection chamber. A temperature sensitive switch will be used to maintain the distillation temperature. Results of the spaceborne experiment likely will not be identical to those from a 1 g reference run, and the reasons for the differences will be explored.

**Spacepak 2: Float Zone Instability Experiment (FZIE).** FZIE is an experiment investigating convective instabilities in float zone geometries. The primary goal of the experiment is to verify the Plateau Instability Limit, which theorizes that in zero gravity a fluid cylinder is unstable when the ratio of length to radius exceeds two degrees. This will be accomplished by melting four independent liquid wax bridges with varying lengths and radii. These bridges are initially held between two copper supports, and the wax is melted by heating one of the copper supports. In addition, by allowing the liquid wax to resolidify under "non-quiet" conditions, a sensitive test of background g-levels can be qualitatively measured by the common distortions in the resolidified float zones.

**Spacepak 3:** This spacepak contains all the batteries needed to power the individual experiment spacepaks.

**Spacepak 4: Pachamama.** The objective of this experiment is to study the effects of microgravity on the photosynthetic ability of the plant lichen. An aluminum air-tight chamber will hold the lichen. The control system will heat the water reservoir to 10 degrees C (50 degrees F), and then each sample will be rehydrated. Temperatures within the measuring chamber will be varied with Peltier heating/cooling chips. Four incandescent light bulbs used for growth lighting then will be turned on to start photosynthesis. The data acquisition will begin after a suitable time for rehydration and will be done through a pair of photometric sensors. Measurements will be made at five different temperatures to characterize the temperature response of the organism.

**Spacepak 5: Bubble Interferometer Experiment.** The objectives of this experiment are to: a) observe the formation of bubbles in a microgravity environment, b) look for evidence of drainage in the bubble after it has been formed, c) look for interference bands due to bubble wall thickness gradients and, d) observe surface tension induced motions on the bubble surface. Bubbles will be formed from a mixture of Dow Corning 704 diffusion pump oil and FC-430 surfactant. The critical bubble blowing sequences will be recorded by an 8 mm camera, while ancillary data, i.e. temperatures, will

be stored digitally in an EPROM (an erasable programmable read-only memory chip).

Bubbles will be blown with the help of two linear actuators and an air pump. The camera will record the bubble blowing sequence. A fluorescent lamp is used to provide lighting during the filming sequence. A small incandescent lamp is used to heat the bubble surface. The heating is not uniform and causes a gradient in the surface tension. This induced surface tension gradient will cause movement of the material on the bubble surface.

### **G-325**

Customer: Norfolk Public Schools, Norfolk, Va.

Customer: Dr. Gene Carter

Payload Manager: Joy Young

This experiment is intended to record visually how sound affects dust particles in near-zero gravity, hopefully contributing to a better understanding of acoustics.

The NORSTAR (Norfolk Public Schools Science and Technology Advanced Research) consists of high school students from Norfolk Public Schools. The program was designed to provide a learning experience for high school students while building a working experiment to fly on the Space Shuttle. The NORSTAR experiment is unique because it remains a student-designed, student-run experiment. Education is the main program objective.

The G-325 acoustical experiments will be conducted in a 5-cubic-foot GAS canister. Two 21-inch clear acrylic tubes will be suspended from a box containing two titanium tweeters (high frequency speakers). A separate function generator will be connected to each tweeter to supply the sound and an amplifier will amplify the sound. Inside each test chamber there will be approximately five grams of cork dust as a medium to visualize the modal patterns created by acoustic standing waves at resonances of the test chambers. Different patterns will be formed as the frequency range from 6000 to 7499 Hz runs through Test Chamber 1. A frequency range from 7500 to 9000 Hz will be run through Test Chamber 2. In the microgravity environment of space, the cork particles will be free to move without the constraints of gravity and will form floating discs at the nodes of the standing waves. The three-dimensional modal patterns at different frequencies will be videotaped.

Although the primary object of the NORSTAR GAS-325 project is to study acoustical standing wave modal patterns on a space available basis, there also will be 60 small passive benign experiments placed in a sealed container in the GAS canister. These have been contributed by middle and elementary school classes to more widely share the excitement of space experimentation. The passive experiments will fall primarily into the

physical sciences category and will seek to discover and/or measure the effects of space and microgravity on prepared samples.

**G-417**

Customer: Beijing Institute of Environmental Testing, Beijing, China

Payload Manager: Ke Shouquan

Three experiments submitted by three different students will be carried out on G-417. One of the student experiments was organized and sponsored by the American Association for the Promotion of Science in China and the Chinese Society of Astronautics. The Beijing Institute of Satellite Environmental Engineering designed and developed the payload.

Experiment #1, the Reproduction of Parameciums, will study the effects of microgravity on the reproduction of insects. Experiment #2 will study contact between oil and water droplets for investigating the effect of microgravity on surface interaction of different kinds of liquids. Experiment #3 involves conducting a general survey of surface interaction of solids and liquids under microgravity conditions.

**G-453**

Customer: The Society of Japanese Aerospace Companies, Inc. (SJAC), Tokyo, Japan

Customer: N. Tateyama

Payload Manager: Takemasa Koreki

This experiment will investigate the formation of superconducting material and the boiling phenomenon under microgravity and the absence of convection. There will be two experiments carried out:

1. Formation of Silicon-Lead (Si-Pb) Alloy:

To investigate the formation of superconducting alloy (not mixable on the ground). Each sample, in a platinum crucible located inside a quartz ampule (small glass container), will be heated in a furnace up to 1450 degrees C (2640 degrees F) for 25 minutes.

2. Boiling Experiment:

To observe the bubble formation when an organic solvent (Freon 113) is boiling under microgravity and the absence of convection. The organic solvent in a small sealed vessel is heated and boiled. The behavior of bubbles formed while boiling is observed and recorded using a video system.

This payload was flown on board STS-57 in June 1993. Some of the experiments at that time were not continued until the final sequence because of inadequate battery capacity. Scientists are eager to pursue the space experiments which were not completed on the STS-57 flight.

**G-454**

Customer: The Society of Japanese Aerospace Companies, Inc. (SJAC),  
Tokyo, Japan

Customer: N. Tateyama

Payload Manager: Takemasa Koreki

This experiment will investigate the crystallization or the formation of materials under microgravity and the absence of convection. Two kinds of experiments will be carried out:

1. Crystal growth of 3-Selenic-Niobium (NbSe<sub>3</sub>) from the vapor phase. To investigate the process of the crystal growth from the vapor phase of the one-dimensional electric conducting material, each sample in a quartz ampule will be heated in a temperature gradient furnace up to 900 degrees C (1650 degrees F) for 20 minutes. At the high temperature end of the furnace, NbSe<sub>3</sub> will be vaporized and crystallized at the other (lower temperature) end of the furnace.
2. Crystal growth of the optoelectronic crystal by the diffusion method. To investigate the diffusion process of the optoelectronic crystal growth from the saturated solution. Two organic solvents (potassium-hydrogen-phosphate KH<sub>2</sub>PO<sub>4</sub> and ethanol C<sub>2</sub>H<sub>5</sub>OH) are separated into two chambers by a partition wall. In space, when the partition wall is removed, the optoelectronic crystal will be grown. The process of the crystal growth will be observed for 24 hours using a video system intermittently.

**G-456**

Customer: The Society of Japanese Aerospace Companies, Inc. (SJAC),  
Tokyo, Japan

Customer: N. Tateyama

Payload Manager: Takemasa Koreki

An electrophoresis (the movement of suspended particles through a fluid or gel under the action of an electromotive force applied to electrodes in contact with the suspension) has a number of important advantages for the separation and isolation of cells or biologically active materials. Therefore, the electrophoresis is being studied, particularly in the area of drug manufacturing for biological/biotechnological products.

In microgravity, the effects of sedimentation, buoyancy and thermal convection, all of which involve differences in density, will decrease. In this experiment, a mixture of the samples will be separated by free-flow electrophoresis in a microgravity environment. Free-flow electrophoresis is a continuous electrophoretic separation method, using a carrier solution which is flowing as a thin liquid film under laminar conditions through the separation chamber. The direction of the flow of the carrier solution (linear flow velocity) is perpendicular to the direction of an electrical field. The samples are separated by this electrical field according to their different

electrophoretic mobility or their different isoelectric point and are migrating in the form of narrow zones to the end of the separation chamber. The phenomena of this separation are observed by a video camera above the separation chamber and recorded by video cassette recorders. Results of this separation will be compared to results obtained on the Earth's surface.

#### **G-485**

Customer: European Space Agency/ESTEC FTD, The Netherlands

Customer: Manfred Trischberger

Payload Manager: Andre Robelet

G-485 was developed by Crisa (Spain) under the auspices of the In-Orbit Technology Demonstration Program of the European Space Agency. The payload is designed to test the feasibility of depositing different materials in a microgravity and vacuum environment. To do this, the payload is being flown in a GAS canister with a Motorized Door Assembly (MDA).

Inside the GAS canister, the payload is divided into two sections: The lower volume which contains the battery and electronics (under 1 atmosphere of pressure) and the experiment chamber, which has the evaporation sources and the target substrates that will be exposed to vacuum when the MDA is opened in orbit. The experiment chamber contains the ceramic effusion cells (crucibles) for processing aluminum and silicon and molybdenum filament for evaporating gold. Each evaporation source is located within a separate compartment in the experiment chamber. In each compartment, mounted opposite the evaporation source, is a target substrate panel. These panels are composed of six different materials (glass, silicon, alumina, sapphire, gallium arsenide and transmission electron microscopy grids).

Once in orbit, the MDA is opened, the vacuum gauge measures the chamber environment and the experiment sequence starts. The evaporation sources are operated sequentially and, upon completion, the MDA is closed, and the experiment chamber kept under vacuum until de-integration to protect the substrates from contamination.

#### **G-506**

Customer: Goddard Space Flight Center, Greenbelt, Md.

Customer: Lawrence R. Thomas

Payload Manager: James Houston

The Orbiter Stability Experiment (OSE) was designed originally to evaluate the Space Shuttle as a platform for imaging the Sun in x-rays and extreme ultraviolet light. Although the Spacelab instrument that was being planned at that time was never funded for development, the OSE in its two previous flights has provided valuable information on the performance of the orbiter's high-frequency stability, that is, the steadiness with which it is oriented in space. Steadiness is measured by observing the position of the Sun with high precision optical sensors mounted rigidly on the top of a GAS

canister. The measurements are made 60 times a second, and the location of the Sun is determined relative to the Orbiter to a small fraction of an arc second.

These data tell about the angular vibration produced by small thruster firings and human activity in the Orbiter cabin. Additional information has been obtained on the accuracy with which a GAS canister can be installed and aligned relative to the orbiter's structure. Such information is useful to other experimenters who are planning to fly instruments requiring accurate pointing by the Shuttle.

The OSE was designed and built by Goddard's Laboratory for Astronomy and Solar Physics, Code 680, using funds provided by the Director's Discretionary Fund and with several major flight components lent by the Engineering Directorate, Code 700, and the Suborbital Projects and Operations Directorate, Code 800. The instrument manager is James Houston, and principal electronics technician is Thomas B. Plummer. Werner M. Neupert is principal investigator.

This will be the third flight of the instrument, previously flown on STS-40 and STS-60. As a GAS payload, the experiment is not able to request solar pointing by the Shuttle, but in two previous flights, experimenters were able to take advantage of solar pointing carried out as part of the Shuttle's timeline for engineering tests.

In addition to the vibration measurements that are planned, the OSE also carries a passive experiment to evaluate the effects of radiation on photographic film. That experiment was developed and provided by Dr. Ernest Hammond of Morgan State University. The GAS container also carries seeds provided by students in the NASA Scientific Knowledge for Indian Learning and Leadership (SKILL) program for 9th through 12th grade high school students. The seeds will be used to study the effects of radiation and zero gravity on germination and growth. This program is administered by the South Dakota School of Mines and Technology, collaborators in this NASA-funded program.

#### **G-562**

Customer: Canadian Space Agency, Ontario, Canada  
Customer and Payload Manager: R.D. Hendry

The Get Away Special payload QUESTS-2 is a materials science payload funded by the Canadian Space Agency and is a re-flight of G-521 flown in September 1992.

The QUESTS payload consists of 15 furnaces, a computer control system, a data acquisition system and batteries. There are two types of furnaces: temperature-gradient (for directional crystal growth studies) and constant-temperature (for metal diffusion studies).

There are three experiments on QUESTS-2. Following is a description of each:

### **Experiment #1 - Queen's University**

The Queen's University experiment involves eight samples: Two are eutectics (alloy composition having lowest melting point), and six are for Ostwald ripening (how the size distribution of droplets of one metal changes with time).

In the original QUESTS project, the two Queen's University eutectic specimens produced startling results, namely, the spacing between the "rods" of one material was found to be unaltered in zero-gravity, despite claims to the contrary of other workers in the U.S. and Europe. The antimony-magnesium specimens to be flown on QUESTS-2 will provide data on the growth behavior of rod-type eutectics. Scientists hope that this data will be used to develop models to predict the microstructure of eutectics likely to be present when processing eutectic materials in space vehicles such as the International Space Station and Mir.

An immiscible alloy is one in which two components do not mix in the molten state, and droplets of one metal are formed in the melt of the other metal. In Ostwald ripening, the distribution of size of the droplets changes - the smaller droplets will become smaller over time, while the larger droplets become larger (i.e. the distribution "ripens"). On Earth, two mechanisms are responsible: Marangoni (surface-tension driven) convection and diffusion, in which the smaller droplets start to become smaller over time as they slowly dissolve and the material diffuses, while the larger droplets become larger as the dissolved material comes out of the large droplets.

The QUESTS-2 experiment is designed to develop a better understanding of droplet growth in liquid-liquid systems by adding particles of a third material to constrain the motion due to surface tension forces, while the microgravity will eliminate gravity-driven settling. Aluminium-indium and aluminum-bismuth are the two alloys to be studied.

### **Experiment #2 - University of Manitoba**

Metal-matrix composites offer excellent mechanical properties which, when combined with light weight and stiffness, make them a suitable material for applications demanding high performance. Most metal-matrix composites are reinforced with randomly-oriented, high-strength fibers, which are either mechanically mixed in the metal powder or in the molten alloy.

The strength of these meta-matrix composites can be improved further by aligning the fibers in the same direction, accomplished by directional solidification (from one end) alloys such as aluminum-nickel, which produce

strong fibers of  $\text{NiAl}_3$  in a matrix of aluminum. However, composites produced on Earth contain many defects, and depending on the growth rate, the shape of the fibers can be round or long. Scientists believe that the gravity-driven flow of the melt on Earth may be responsible for these phenomena. Composite material grown in zero-gravity should be more uniform than that grown on Earth.

### **Experiment #3 - Ceramics Kingston Ceramique**

This company currently is developing a range of new materials for use in the next generation of high performance, fuel-efficient aircraft. High-strength fibers or particles of one material are added to the melt of a second, lighter weight metal. Because the densities of the two components are quite different, one component settles to the bottom because of gravity, and the mixing is uneven. In addition, further unevenness in the mixing can occur from thermally-induced flow in the melt. This uneven mixing leads to degraded material properties.

The Shuttle tests allow the separation of the gravitational and non-gravitational effects. Using the Shuttle, "ideal" samples of materials can be made in the microgravity environment. These materials will be used as benchmarks to compare with materials produced on Earth and to gain an understanding of the various phenomena which can degrade product quality and their respective importance.

In the QUESTS-2 experiments, aluminum is used as a model system. Samples of aluminum reinforced with various materials are to be melted then solidified, both on Earth and on the Shuttle. The distribution of the reinforcing material is to be compared to gain an understanding of the process and the relative importance of the various phenomena influencing the properties.

## **SIMPLIFIED AID FOR EXTRAVEHICULAR ACTIVITY RESCUE (DTO 661)**

STS-64 crew members Mark Lee (EV1) and Carl Meade (EV2) will perform a six-and-a-half hour spacewalk on flight day eight of the mission to evaluate the Simplified Aid For EVA Rescue (SAFER); several spacewalking tools; and an Electronic Cuff Checklist developed to allow spacewalkers greater and easier access to information. During the spacewalk, STS-64 crew member Jerry Linenger will serve as the Intravehicular Crewmember (IV), assisting the spacewalkers with their work from within Discovery's crew cabin.

SAFER, designed and developed by the Johnson Space Center in a team project led by the Automation and Robotics Division, is a small, self-contained, propulsive backpack device that can provide free-flying mobility for a spacewalker in an emergency. It is designed for self-rescue use by a spacewalker in the event the Shuttle is unable or unavailable to retrieve a detached, drifting crew member. Examples of such times may include a mission where the Shuttle is docked to the Russian Mir Space Station or to the International Space Station.

SAFER is attached to the spacesuit's Portable Life Support System backpack, and is, in essence, a scaled-down, miniature version of the Manned Maneuvering Unit propulsion backpack flown aboard Shuttle missions in 1984. It is designed for emergency use only, but without built-in backup systems. SAFER's propulsion is provided by 24 fixed-position thrusters that expel nitrogen gas and have a thrust of .8 lbs. each. Stowed in the crew cabin for launch and landing, SAFER's nitrogen supply can be recharged in orbit from the Shuttle's nitrogen system. SAFER's three-pound supply of nitrogen can provide a ten-foot-per-second change in velocity for the operator before it is exhausted. Its attitude control system includes an automatic attitude hold and six degrees of freedom. A 28-volt battery pack for SAFER can be replaced in orbit.

For STS-64, first Lee, and then Meade, will evaluate SAFER through four test sequences: A SAFER familiarization, a system engineering evaluation, a rescue demonstration, and a flight qualities evaluation. The SAFER flight operations will be conducted without a tether attached to the Shuttle. The familiarization will have the SAFER spacewalker perform several short single-axis translation and then rotation commands. They will be performed first with the unit's automatic attitude hold "on" and again with the attitude hold "off". Next, the spacewalker will fly a square trajectory within the Shuttle payload bay, recording the percent of nitrogen used both before and after the maneuver to compare the actual use with what had been predicted.

For the engineering evaluation, the spacewalker will fly several short translation commands, for example, a one-second thrust forward, five seconds of coasting, and a one-second braking thrust. The same type of command will be done for rotations as well, and a data recorder in the

SAFER will retain all measurements of the unit's performance for study on the ground after the mission.

The self-rescue demonstration will have one spacewalker--standing in a foot restraint at the end of Discovery's mechanical arm--impart a series of rotations to the SAFER spacewalker. The SAFER spacewalker will then activate the unit's automatic attitude hold system to stop the rotation and fly back to the end of the arm, which will have slowly been backed away. The rotations will not exceed a speed of 30 degrees per second, a rate well below the design capability of SAFER.

The flight qualities evaluation will have the spacewalker fly a precision trajectory that will follow the Shuttle's bent mechanical arm. Next, he will fly a precision approach from the elbow of the arm to the aft flight deck windows of the Shuttle, establishing a hover one foot away from the windows.

Between each test sequence, SAFER will be recharged with nitrogen from the Shuttle's nitrogen supply via a SAFER Recharge Station mounted in the forward portion of the cargo bay. In addition, before the unit is switched from Lee to Meade, the SAFER battery will be changed.

#### **DTO 671: EVA Hardware for Future Scheduled EVA Missions**

Throughout the spacewalk, Lee and Meade will evaluate several new and some improved spacewalking tools. These include quick-release tether hooks and wrist tethers, push-button portable foot restraints, a rigid tether, modified handrails and an articulating portable foot restraint. Except for the articulating portable foot restraint, which will have specific time scheduled for its evaluation, these tools will be evaluated by the spacewalkers as they use them to work on the SAFER tests.

#### **DTO 672: Extravehicular Mobility Unit Electronic Cuff Checklist**

One new piece of spacewalking equipment to be worn and evaluated by both Lee and Meade is called the Electronic Cuff Checklist (ECC).

The Electronic Cuff Checklist, developed by the Johnson Space Center's Crew and Thermal Systems Division, attaches to the lower arm of a spacesuit and can hold more than 500 pages of information, including graphics and even photographs, to display on a 3-by-4-inch screen. Roughly the same size as the current printed checklist, the two-and-a-half-pound, battery-powered unit is an inch deep at its thickest point.

The standard checklist currently worn by spacewalkers is a printed notebook, usually 25-50 pages long, worn on the cuff of the spacesuit during a spacewalk. It normally contains only a small amount of critical information, such as emergency spacesuit operations. The Electronic Cuff Checklist would allow spacewalkers to have quick, easy access to much more

information that will be useful as work in space becomes more complex, such as during the Hubble Space Telescope servicing spacewalks.

The Electronic Cuff Checklist also has the capability to be altered during a flight. Information can be loaded into the checklist on orbit from a laptop computer carried on the Shuttle.

The unit's flat screen has a resolution roughly equivalent to that of a standard television set -- 320 by 240 pixels -- that may give it the ability to display graphics and photographs. The screen is divided into six different touch-sensitive buttons that allow instant access to various categories of information. It is designed for easy operation when wearing bulky spacesuit gloves. A touch and hold feature built into the checklist allows ready access to special functions, including an emergency page. The checklist also includes a mission elapsed time clock and a spacewalk elapsed time clock.

The checklist has about two megabytes of memory, is powered by standard AA batteries and can operate up to 12 hours on one battery pack.

On STS-64, Lee and Meade each will wear the Electronic Cuff Checklist on the left arm of his spacesuit and a standard, printed checklist on the right arm. The electronic checklist will include the information on the printed checklist plus additional information, including the spacewalk timeline and complete SAFER evaluation procedures. The electronic checklist will be evaluated in parallel with the other spacewalk operations on its size, weight, viewability, accessibility of information, attachment to the suit and general operation. In addition, after the spacewalk is completed, new pages of information will be transferred to the unit from the laptop computer aboard Discovery to test that capability.

## **SHUTTLE PLUME IMPINGEMENT FLIGHT EXPERIMENT**

The Shuttle Plume Impingement Flight Experiment (SPIFEX), designed and built by a team of Johnson Space Center scientists and engineers, will study the characteristics and behavior of exhaust plumes from Discovery's Reaction Control System (RCS) thrusters during STS-64.

SPIFEX, when picked up by Discovery's mechanical arm, is a 33-foot long extension for the arm with a package of instruments that will measure the near-field, transition and far-field effects of thruster plumes. The plume information gathered by the experiment will assist planners in understanding the potential effects of thruster plumes on large space structures, such as the Russian Space Agency's Mir Space Station and the International Space Station, during future Shuttle docking and rendezvous operations.

During STS-64, SPIFEX will be moved by a series of complex mechanical arm maneuvers to take measurements of 86 separate test firings of the Shuttle's RCS thrusters at 60 different locations. The majority of locations will have SPIFEX either above the nose of Discovery, in front of the nose, or at the rear of the spacecraft near the left Orbital Maneuvering System pod. Operations of the experiment are scheduled on four different flight days of the mission and are planned to gather a total of 12 to 14 hours of data during the flight.

In addition to the thruster plume data, a Get-Away Special canister in Discovery's cargo bay will contain cold gas that will be released during the SPIFEX operations to fine-tune the experiment's instruments. Most of the SPIFEX data will be recorded aboard Discovery on a laptop computer for analysis after landing. Some data, however, may be transmitted immediately to ground scientists.

The SPIFEX instruments are comprised of three basic systems: A Load Measurement System; a Plume Impingement Characterization System; and a Position and Orientation Verification System. The load measurements will obtain information on the pressures that might be imparted by the jet plumes to delicate structures such as solar arrays, while the characterization measurements will detail the concentrations of contaminants from exhaust plumes. All of the operations will be done at a variety of distances from and orientations to the Shuttle steering jets. The primary crew member for SPIFEX mechanical arm operations will be Susan Helms, although the experiment will require two additional crewmembers during each data take -- one to operate the laptop computer and another to perform the jet firings.

## **Solid Surface Combustion Experiment (SSCE)**

The Solid Surface Combustion Experiment (SSCE) is a major study of how flames spread in a microgravity environment ( $10^{-6}g$ ). Conducting the flame spreading experiment in microgravity removes buoyant air motion caused by gravity, commonly observed as "hot gases rising." Comparing microgravity results with test results obtained in normal gravity on Earth (1 g) provides detailed information about how air motion affects flame spreading. The SSCE results will contribute to improvements in fire safety equipment and practices both on Earth and in spacecraft.

This is the seventh of eight Space Shuttle flights planned for the SSCE. During the STS-64 mission, a small sample of PMMA, or Plexiglas, will be burned in a mixture of 50 percent oxygen and 50 percent nitrogen at twice normal atmospheric pressure.

After the mission, comparisons of burning behavior in microgravity and normal gravity will be made by engineers and scientists at NASA's Lewis Research Center, Cleveland, Ohio, and by Principal Investigator, Professor Altenkirch and his team at Mississippi State University. In addition, Professor Altenkirch will compare the test results with a complex computer simulation of flame spreading, which he and his students have developed from over a decade of research in this field.

The results of earlier flights of the SSCE have been published in scientific literature. Those data resulted in the modification of the theoretical flame spreading simulation, particularly in the description of how the fuel is vaporized by the flame before burning.

The SSCE experiment is sponsored by NASA's Office of Life and Microgravity Sciences and Applications and is managed by the Lewis Research Center.

## **Biological Research in Canisters (BRIC-2)**

Research on the development and differentiation of a major food crop family that provides half of the world's calorie intake from plants, is the subject of the second Biological Research in Canisters (BRIC-2) experiment on STS-64. Microgravity research on orchard grass, which is part of the plant family that includes wheat, rice and corn, possibly will provide critical insights into the reproductive biology of the world's major food crops.

Orchard grass, the subject of BRIC-2, provides an ideal subject for studying and understanding food crops as part of an environmental system of food production and waste recycling for long duration space missions, the International Space Station and as part of the ecology of Earth.

On STS-64, for the first time, basic microgravity research on a member of the grass family will be performed. Leaf cultures will be grown in a fixed nutrient "soil" as opposed to having to be placed in suspension. Leaf sections will be split providing for excellent research controls and statistical analysis. Finally, a fixed number of the seeds will develop fully and will be germinated and grown to full plants for further research. All portions of the orchard grass, such as leaf, veins, etc., will be analyzed to understand the development and life cycle of the plant.

The principal scientist for this experiment is Dr. Robert Conger, Department of Plant and Soil Science from the University of Tennessee in Knoxville. For Dr. Conger's research, orchard grass leaf segments will be placed in a special nutrient broth in petri dishes in a BRIC 100 canister. The experiment will be sealed and housed in the mid-deck of the Space Shuttle. The experiment is passive and requires no in-flight manipulation. It does require immediate removal from the Shuttle after landing to assess the effects of microgravity on the reproductive and regeneration systems of the plants before the effects of full gravity are reestablished.

BRIC experiments are sponsored by NASA's Office of Life and Microgravity Sciences and Applications (OLMSA) Small Payloads Program, and are designed to examine the effects of microgravity on a wide range of physiological processes in higher order plants and arthropod animals, such as insects, spiders, centipedes and crustaceans.

## **Shuttle Amateur Radio EXperiment (SAREX)**

Students in the U.S. and New Zealand will have a chance to speak via amateur radio with astronauts aboard the Space Shuttle Discovery during STS-64. Ground-based amateur radio operators ("hams") also will be able to contact the Shuttle through automated computer-to-computer amateur (packet) radio links. There also will be voice contacts with the general ham community as time permits.

Shuttle Commander Dick Richards (KB5SIW), pilot Blaine Hammond, Jr., (KC5HBS) and mission specialist Jerry Linenger (KC5HBR) will talk with students in 10 schools in the U.S. and New Zealand using "ham radio."

Students in the following schools will have the opportunity to talk directly to orbiting astronauts for approximately 4 to 8 minutes:

- \* Grizzly Hill School, North San Juan, Calif. (N6NYY)
- \* The Branson School, Ross, Calif. (KC6VIM)
- \* Crystal Lake South Elementary, Crystal Lake, Ill. (N9NJF)
- \* Morocco Elementary School, Morocco, Ind. (N9GBM)
- \* Dwight D. Eisenhower Middle School, Laurel, Md. (N3MJA)
- \* Springfield Plains Elementary, Clarkston, Mich. (K8ZZU)
- \* Francis Howell North H.S., St. Charles, MO (K00Z)
- \* Central Square Middle School, Central Square, N.Y. (N2STK)
- \* STEP/Star Schools-Young Astronauts, Spokane, Wash. (WB7NNF)
- \* Middleton Grange School, Christchurch, New Zealand (ZL3JG)

The radio contacts are part of the SAREX (Shuttle Amateur Radio EXperiment) project, a joint effort by NASA, the American Radio Relay League (ARRL), and the Radio Amateur Satellite Corporation (AMSAT).

The project, which has flown on 14 previous Shuttle missions, is designed to encourage public participation in the space program and to support the conduct of educational initiatives through a program to demonstrate the effectiveness of communications between the Shuttle and low-cost ground stations using amateur radio voice and digital techniques.

Information about orbital elements, contact times, frequencies and crew operating schedules will be available during the mission from NASA, ARRL (Steve Mansfield, 203/666-1541) and AMSAT (Frank Bauer, 301/ 286-8496). AMSAT will provide information bulletins for interested parties on Internet and amateur packet radio. The ARRL bulletin board system (BBS) number is (203) 688-0578.

The ARRL ham radio station (W1AW) will include SAREX information in its regular voice and teletype bulletins.

Mission information will be available online from the Johnson Space Center computer bulletin board (8 N 1 1200 baud): dial (713) 244-5625.

BBS information is available from the Goddard Space Flight Center amateur radio club via Internet. The address is: wa3nan.gsfc.nasa.gov.

The amateur radio station at the Goddard Space Flight Center, (WA3NAN), will operate during the mission, providing SAREX information, retransmitting live Shuttle air-to-ground audio, and retransmitting some of the SAREX school group contacts.

### **STS-64 SAREX Frequencies**

Routine SAREX transmissions from the Space Shuttle may be monitored on a worldwide downlink frequency of 145.55 MHz.

The voice uplink frequencies are (except Europe):

144.91 MHz

144.93

144.95

144.97

144.99

The voice uplink frequencies for Europe only are:

144.70

144.75

144.80

**Note:** The astronauts will not favor any one of the above frequencies. Therefore, the ability to talk with an astronaut depends on selecting one of the above frequencies chosen by the astronaut.

The worldwide amateur packet frequencies are:

Packet downlink 145.55 MHz

Packet uplink 144.49 MHz

The Goddard Space Flight Center amateur radio club planned HF operating frequencies are:

3.860 MHz

14.295

28.650

7.185

21.395

### **RADIATION MONITORING EQUIPMENT-III**

The Radiation Monitoring Equipment-III (RME-III) measures ionizing radiation exposure to the crew within the orbiter cabin. RME-III measures gamma ray, electron, neutron and proton radiation and calculates in real time exposure in RADS-tissue equivalent. The information is stored in a memory module for post-flight analysis.

The hand-held instrument is stored in a mid-deck locker during flight except for when the crew activates it and replaces the memory module every two days. RME-III will be activated by the crew as soon as possible after they achieve orbit, and it will operate throughout the mission. A crew member will enter the correct mission elapsed time upon activation. RME-III is sponsored by the Department of Defense in cooperation with NASA.

### **MILITARY APPLICATIONS OF SHIP TRACKS**

The Office of Naval Research (ONR) is sponsoring the Military Applications of Ship Tracks (MAST) experiment on STS-64. MAST is part of a five-year research program developed by ONR to examine the effects of ships on surrounding clouds and aerosols. The Naval Postgraduate School, Monterey, Calif., will conduct the experiment at the Johnson Space Center during the mission. The objective of MAST is to determine how effluents generated by ships modify the reflective properties of clouds. Ship tracks are observed in satellite imagery as long, narrow, curvilinear cloud features that have greater brightness than the surrounding clouds. The STS-64 crew will photograph ship tracks using handheld cameras. These high-resolution photographs will provide insight into the processes of ship track production on a global scale. MAST is a Department of Defense payload and is being flown under the direction of the DOD Space Test Program.

## STS-64 CREW BIOGRAPHIES

**Richard (Dick) N. Richards**, 48, Capt., USN, will command STS-64. Selected as an astronaut in 1980, Richards considers St. Louis, Mo., his hometown and will be making his fourth space flight.

Richards graduated from Riverview Gardens High School, St. Louis, in 1964. He received a bachelor's degree in chemical engineering from the University of Missouri in 1969 and received a master's degree in aeronautical systems from the University of West Florida in 1970. Richards graduated from the Naval Test Pilot School, Patuxent River, Md., in 1976.

After joining NASA, Richards first Shuttle flight was as pilot of STS-28, a Department of Defense-dedicated mission in August 1989. He next flew as commander of STS-41, a mission that deployed the Ulysses probe to study the Sun's polar regions, in October 1990. His third flight was as commander of STS-50, the first flight of the United States Microgravity Payload.

Richards has logged more than 22 days and 22 hours in space, and more than 5,100 hours flying time in over 16 different types of aircraft.

**L. Blaine Hammond, Jr.**, 42, Col., USAF, will serve as pilot. Selected as an astronaut in 1984, Hammond considers St. Louis, Mo., his hometown and will be making his second space flight.

Hammond graduated from Kirkwood High School, Kirkwood, Mo., in 1969. He received a bachelor's degree in engineering science and mathematics from the Air Force Academy in 1973 and a master's degree in engineering science and mathematics from the Georgia Institute of Technology in 1974.

Hammond, as an Air Force pilot and instructor pilot, attended the Empire Test Pilot School, Boscombe Down, England, in 1981. He later served as a test pilot at Edwards Air Force Base, Calif., before being assigned as an instructor at the Air Force Test Pilot School, where he was serving when selected by NASA.

Hammond's first Shuttle flight was as pilot of STS-39 in May 1991, the first unclassified Department of Defense-dedicated mission that collected data on atmospheric infrared and ultraviolet phenomena as well as in support of the Strategic Defense Initiative Office.

Hammond has logged more than 199 hours in space and more than 4,200 hours flying time in 15 different types of U.S. aircraft and 10 types of British aircraft.

**J. M. (Jerry) Linenger**, 39, M.D., Ph.D., Cdr., Medical Corps, USN, will serve as Mission Specialist 1 (MS1). Selected as an astronaut in 1992,

**Linenger considers Eastpointe, Mich., and Coronado, Calif., his hometowns and will be making his first space flight.**

**Linenger graduated from East Detroit High School, Eastpointe, Mich., in 1973; received a bachelor's degree in bioscience from the Naval Academy in 1977; received a doctorate in medicine from Wayne State University in 1981; received a master's degree in systems management from the University of Southern California in 1988; received a master of public health degree in health policy from the University of North Carolina in 1989; and received a doctorate in epidemiology from the University of North Carolina in 1989.**

**Linenger completed his surgical internship at Balboa Naval Hospital, San Diego, Calif., and aerospace medicine training at the Naval Aerospace Medical Institute, Pensacola, Fla. He first served as a Naval flight surgeon at Cubi Point, Republic of the Philippines, and was later assigned as medical advisor to the commander, Naval Air Forces, U.S. Pacific Fleet, in San Diego. After receiving a doctorate in epidemiology, he served as a research principal investigator at the Naval Health Research Center, where he was assigned when selected by NASA.**

**Susan J. Helms, 36, Lt. Col., USAF, will serve as Mission Specialist 2 (MS2). Selected as an astronaut in 1990, Helms considers Portland, Or., her hometown and will be making her second space flight.**

**Helms graduated from Parkrose Senior High School, Portland, Or., in 1976; received a bachelor's degree in aeronautical engineering from the Air Force Academy in 1980; and received a master's degree in aeronautics and astronautics from Stanford University in 1985.**

**Prior to her selection by NASA, Helms' work in the Air Force included lead engineer for F-15 weapons separation at the Air Force Armament Laboratory, Eglin Air Force Base, Fla.; assistant professor of aeronautics at the Air Force Academy; graduate of the Air Force Test Pilot School as a flight test engineer in 1988; and service as a flight test engineer and Air Force Exchange Officer with the Aerospace Engineering Test Establishment, Canadian Armed Forces Base, Cold Lake, Alberta, Canada. At the time of her selection, Helms was managing the development of a CF-18 Flight Control System Simulation for the Canadian Armed Forces.**

**Helms' first flight was as a mission specialist on STS-54 in January 1993, a mission that deployed a NASA Tracking and Data Relay Satellite and operated the Diffuse X-Ray Spectrometer, gathering X-ray astronomy data to explore the origins of the Milky Way galaxy.**

**Helms has logged more than 143 hours in space and has flown in more than 30 different types of aircraft as a flight test engineer.**

**Carl J. Meade, 43, Col., USAF, will serve as Mission Specialist 3 (MS3).** Selected as an astronaut in 1985, Meade will be making his third space flight.

Meade graduated from Randolph High School, Randolph Air Force Base, Texas, in 1968; received a bachelor's degree with honors in electronics engineering from the University of Texas in 1973; and received a master's degree in electronics engineering from the California Institute of Technology in 1975.

Meade was a distinguished graduate of undergraduate pilot training at Laughlin Air Force Base, Texas, and later graduated from the Air Force Test Pilot School, receiving the Lichen-Tittle Award as the Outstanding Test Pilot of the class. He was then assigned to the 6510th Test Wing, Edwards Air Force Base, Calif., serving in a variety of research, development and test programs. In 1985, he was assigned as a test pilot instructor at the Air Force Test Pilot School, where he was serving at the time of his selection by NASA.

Meade's first space flight was as a mission specialist on STS-38 in November 1990, a Department of Defense-dedicated mission. He next flew as a mission specialist on STS-50 in June 1992, a mission that carried the first United States Microgravity Laboratory.

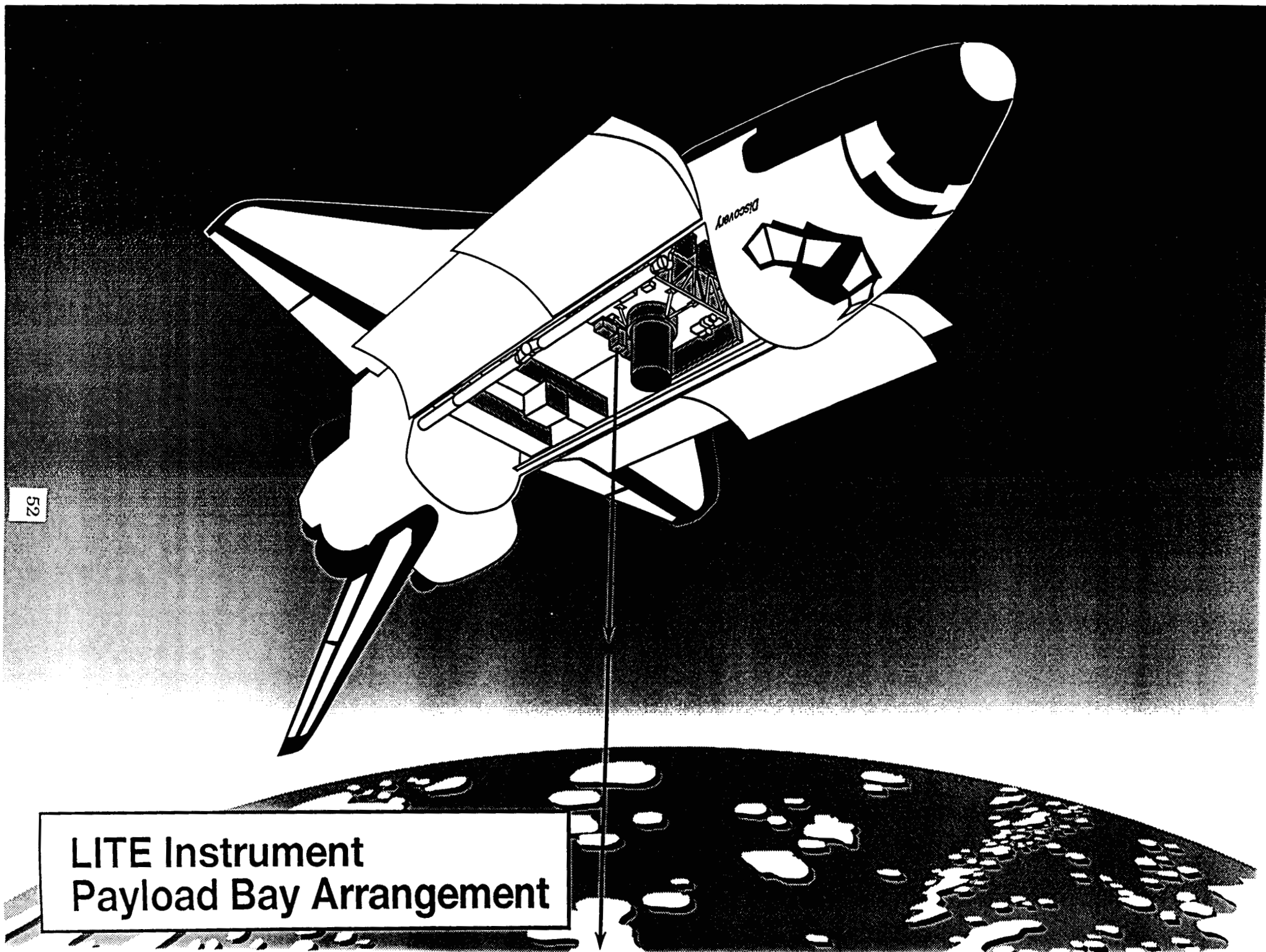
Meade has logged more than 449 hours in space and more than 4,300 hours flying time in 27 different types of aircraft.

**Mark C. Lee, 42, Col., USAF, will serve as Mission Specialist 4 (MS4).** Selected as an astronaut in May 1984, Lee considers Viroqua, Wisc., his hometown and will be making his third space flight.

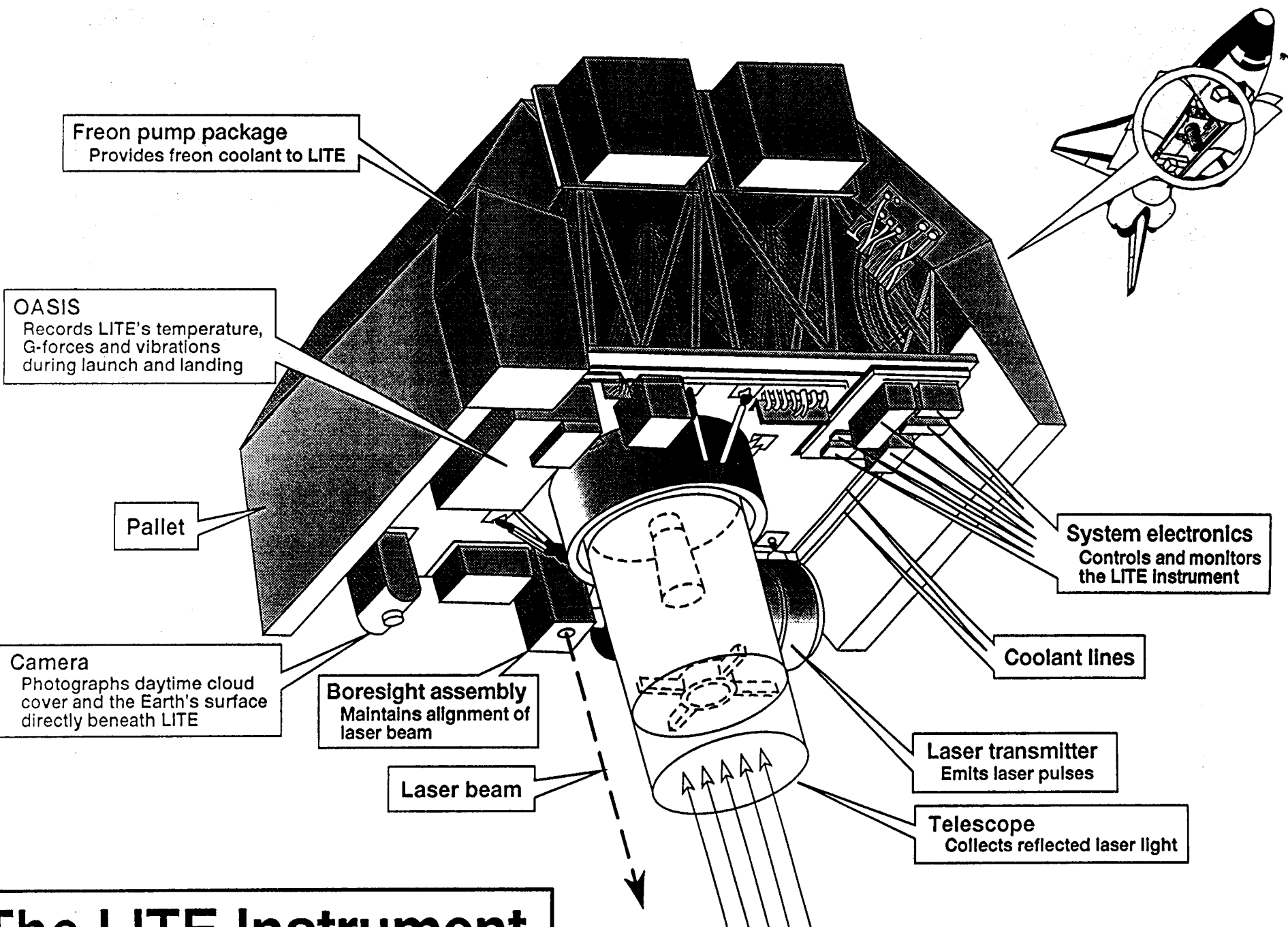
Lee graduated from Viroqua High School in 1970; received a bachelor's degree in civil engineering from the Air Force Academy in 1974; and received a master's degree in mechanical engineering from the Massachusetts Institute of Technology in 1980.

Lee completed Air Force pilot training at Laughlin Air Force Base, Texas, and served at Okinawa Air Base, Japan, flying F-4s. Later, he served as the operations support manager in the Airborne Warning and Control System at Hanscom Air Force Base, Mass. In 1982, he upgraded to fly the F-16, assigned as executive officer for the 388th Tactical Fighter Wing Commander for Operations at Hill Air Force Base, Utah.

Lee's first space flight was as a mission specialist on STS-30 in May 1989, a mission that launched the Magellan planetary probe to map Venus. Lee next flew as the payload commander and a mission specialist on STS-47 in September 1992, a cooperative Spacelab mission between the U.S. and Japan. Lee has logged more than 288 hours in orbit and more than 3,500 hours flying time in various aircraft.

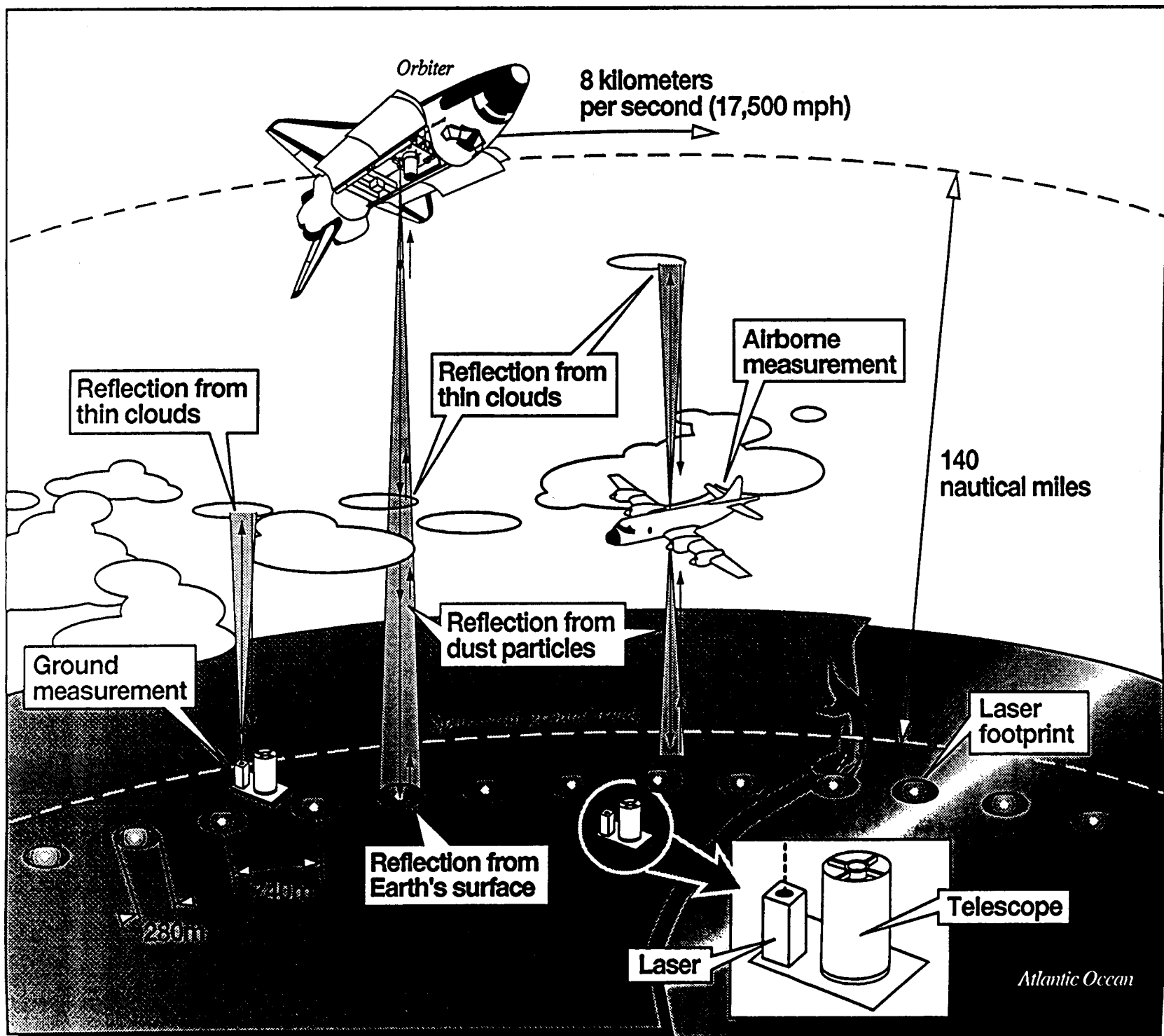


**LITE Instrument  
Payload Bay Arrangement**



# The LITE Instrument

Lidar In-space Technology Experiment



# SHUTTLE FLIGHTS AS OF JULY 1994

63 TOTAL FLIGHTS OF THE SHUTTLE SYSTEM — 38 SINCE RETURN TO FLIGHT

<div> <div>STS-51-L 01/28/83</div> <div>STS-51-A 10/30/83 - 11/06/83</div> <div>STS-51-F 07/29/83 - 08/06/83</div> <div>STS-51-B 04/29/83 - 05/06/83</div> <div>STS-51-G 10/30/83 - 11/03/84</div> <div>STS-51-C 04/06/84 - 04/13/84</div> <div>STS-51-B 02/03/84 - 02/11/84</div> <div>STS-8 08/30/83 - 09/05/83</div> <div>STS-7 06/18/83 - 06/24/83</div> <div>STS-6 04/04/83 - 04/09/83</div> </div> <div>OV-099 Challenger (10 flights)</div>	<div> <div>STS-65 Launched 07/06/94</div> <div>STS-62 03/04/94 - 03/18/94</div> <div>STS-58 10/18/93 - 11/01/93</div> <div>STS-55 04/26/93 - 05/06/93</div> <div>STS-52 10/22/92 - 11/1/92</div> <div>STS-50 06/25/92 - 07/09/92</div> <div>STS-40 06/05/91 - 06/14/91</div> <div>STS-35 12/02/90 - 12/10/90</div> <div>STS-32 01/09/90 - 01/20/90</div> <div>STS-28 08/08/89 - 08/13/89</div> <div>STS-61-C 01/12/86 - 01/18/86</div> <div>STS-9 11/28/83 - 12/08/83</div> <div>STS-9 11/11/82 - 11/16/82</div> <div>STS-4 06/27/82 - 07/04/82</div> <div>STS-3 03/22/82 - 03/30/82</div> <div>STS-2 11/12/81 - 11/14/81</div> <div>STS-1 04/12/81 - 04/14/81</div> </div> <div>OV-102 Columbia (16 flights)</div>	<div> <div>STS-60 02/03/94 - 02/11/94</div> <div>STS-51 09/12/93 - 09/22/93</div> <div>STS-56 04/08/93 - 04/17/93</div> <div>STS-53 12/2/92 - 12/9/92</div> <div>STS-42 01/22/92 - 01/30/92</div> <div>STS-48 09/12/91 - 09/18/91</div> <div>STS-39 04/28/91 - 05/06/91</div> <div>STS-41 10/06/90 - 10/10/90</div> <div>STS-31 04/24/90 - 04/29/90</div> <div>STS-33 11/22/89 - 11/27/89</div> <div>STS-29 03/13/89 - 03/18/89</div> <div>STS-26 09/29/88 - 10/03/88</div> <div>STS-51-I 08/27/85 - 09/03/85</div> <div>STS-51-G 06/17/85 - 06/24/85</div> <div>STS-51-B 04/12/85 - 04/19/85</div> <div>STS-51-C 01/24/85 - 01/27/85</div> <div>STS-51-A 11/08/84 - 11/16/84</div> <div>STS-41-D 08/30/84 - 09/04/84</div> </div> <div>OV-103 Discovery (18 flights)</div>	<div> <div>STS-46 7/31/92 - 8/8/92</div> <div>STS-45 03/24/92 - 04/02/92</div> <div>STS-44 11/24/91 - 12/01/91</div> <div>STS-43 08/02/91 - 08/11/91</div> <div>STS-37 04/05/91 - 04/11/91</div> <div>STS-38 11/15/90 - 11/20/90</div> <div>STS-36 02/28/90 - 03/04/90</div> <div>STS-34 10/18/89 - 10/23/89</div> <div>STS-30 05/04/89 - 05/08/89</div> <div>STS-27 12/02/88 - 12/06/88</div> <div>STS-61-B 11/26/85 - 12/03/85</div> <div>STS-61-J 10/03/85 - 10/07/85</div> </div> <div>OV-104 Atlantis (12 flights)</div>	<div> <div>STS-59 04/09/94 - 04/20/94</div> <div>STS-61 12/2/93 - 12/13/93</div> <div>STS-57 6/21/93 - 7/1/93</div> <div>STS-54 01/13/93 - 01/19/93</div> <div>STS-47 09/12/92 - 09/20/92</div> <div>STS-49 05/07/92 - 05/16/92</div> </div> <div>OV-105 Endeavour (6 flights)</div>
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# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
202 358-1600



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For Release

Sarah Keegan  
Headquarters, Washington D.C.  
(Phone: 202/358-1902)

August 19, 1994

Ed McNevin  
Jet Propulsion Laboratory, Pasadena, Calif.  
(Phone: 818/354-5011)

NOTE TO EDITORS: N94-62

## **GALILEO COMET IMPACT PICTURE RELEASED**

The first picture taken by NASA's Galileo spacecraft of an impact of a fragment of Comet Shoemaker-Levy 9 has been released by the space agency.

The black-and-white image of the collision of comet fragment W consists of four frames taken over a 7-second period. It shows the beginning, brightening and fading of a bright point about 44 degrees south latitude on the far side of Jupiter from the Earth. The four frames were obtained on July 22, 1994, at a distance of about 150 million miles from Jupiter.

News media representatives may obtain copies of the picture by faxing a request to NASA Headquarters' Broadcast and Imaging Branch at 202/358-4333 and requesting photo numbers 94-HC-195 (color) or 94-H-218 (black and white), or by calling NASA's Jet Propulsion Laboratory, Pasadena, Calif., at (818) 354-5011.

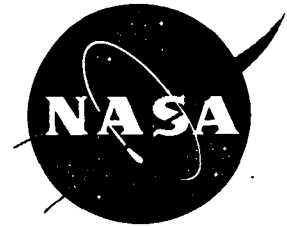
The image may also be accessed by the public electronically by Internet via the World Wide Web system, from JPL's home page at the address <http://www.jpl.nasa.gov/> under the "News" heading; or by anonymous file transfer protocol (FTP) to the address [jplinfo.jpl.nasa.gov](ftp://jplinfo.jpl.nasa.gov) in the "News" directory. The file may also be accessed via JPL's dialup bulletin board system at (818) 354-1333.

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# NASA News

National Aeronautics and  
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202 358-1600



Jim Cast  
Headquarters, Washington, D.C.  
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For Release  
August 19, 1994

RELEASE: 94-136

## NEW DATA BRIGHTENS DEBRIS OUTLOOK FOR SPACE STATION

Recent results from powerful radar measurements of orbital debris are good news for the International Space Station.

NASA has just completed the third year of a campaign measuring and monitoring the orbital debris environment using the Haystack Orbital Debris Radar. The Haystack Radar is operated for NASA by the MIT Lincoln Laboratory, Lexington, Mass. This powerful radar can detect debris objects that are as small as a pea (about 1/4 inch in diameter) orbiting 400 miles out in space.

The orbital debris population measured by Haystack has been compared with predictions of the orbital debris environment based on the NASA "Engineering Model". This model was developed using measurements and data on the debris environment collected prior to 1988. The measured orbital debris population differed from NASA's predictions over all altitudes that were studied using the Haystack Radar.

At low altitudes (250-400 miles) the measured debris population was below predicted levels. Thus, this measurement campaign brings good news to the International Space Station. According to George Levin, NASA's Orbital Debris Program Manager, Washington, D.C., engineers and scientists believe there are three major reasons why their earlier predictions overestimated the Space Station debris population.

"The first reason for this improvement in the orbital debris environment is the success of NASA's Orbital Debris Mitigation Program. Since 1987, following the explosion of an orbiting 3rd stage rocket belonging to the European Space Agency (ESA), NASA has made a concerted effort to inform other spacefaring nations of the hazards to spacecraft resulting from these types of explosions. As a result of these efforts ESA, Japan, China and Russia have all joined NASA in modifying the designs of their launch vehicles and their satellites to minimize the possibility of future accidental explosions in space," said Levin.

A second reason for the improvement in the environment in this region of space can be traced to the major economic and political upheaval that occurred here on Earth during the last decade.

-more-

The end of the cold war saw a dramatic reduction in Russia's military space program. In previous years many intentional explosions of satellites on orbit were attributed to the Russian military space program.

The testing of anti-satellite weapons by both the United States and Russia is believed to be another military space activity which contributed to the low-Earth orbital debris population during the early to mid-80's. The cessation of these anti-satellite tests by both the United States and Russia has helped to reduce the growth of orbital debris.

A third reason for the improvement in the low-altitude space environment also can be attributed to these same economic and political changes. The world-wide launch rate has fallen almost 40 % in the last nine years (from 129 launches in 1984 to 79 launches in 1993).

Levin explained that, "The forces of nature play a large role in affecting the debris environment in low-Earth orbit. Objects in these low (250-400 mile) orbits are affected by changes in the solar cycle. During the peak of the solar cycle the density of the atmosphere increases at these altitudes. This increased density acts to slow down the orbiting debris objects, causing them to re-enter the atmosphere. Thus, much of the debris injected into the proposed Space Station orbit during the early to mid-80's reentered during the unusually strong peak associated with the last solar cycle."

Of increasing concern to NASA is the orbital debris population measured by the Haystack Orbital Debris Radar at higher altitudes (500-650 miles). In these orbits debris was found to be greater than NASA's predictions. Objects in these orbits are not significantly affected by changes in solar activity. Thus, the lifetime of debris in these orbits can exceed 1000 years. The long orbital life at these high altitudes also means that debris in these orbits will not pose a hazard to the Space Station. However, these orbits are important for scientific, Earth observation, weather and communications satellites.

NASA Administrator Daniel S. Goldin has directed NASA engineers and scientists to focus increased attention on these orbits. NASA must first understand the cause of the increased debris population in the 500-650 mile altitude regime. Only then is it possible to determine the actions required to control the growth of debris in this economically important area of space.

In addition the NASA Administrator has reaffirmed the space agency's commitment to continue to work, both within the U.S. Government as well as with other spacefaring nations, to protect the space environment for future generations.

# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
202 358-1600



For Release  
August 23, 1994

Laurie Boeder  
Headquarters, Washington, D.C.  
(Phone: 202/358-1898)

RELEASE: 94-137

## **MANSFIELD TO LEAD NEW OFFICE OF SPACE ACCESS AND TECHNOLOGY**

NASA announced today the formation of the Office of Space Access and Technology (Code X) at NASA Headquarters in Washington, D.C. John E. Mansfield has been selected as the new NASA Associate Administrator for the office.

The new office was created through a merger of the Office of Advanced Concepts and Technology (Code C) and the Office of Space Systems Development (Code D). This merger produces a leaner overall organization with a greater focus on the development of advanced space technologies and future space launch systems. It retains the new ways of doing business and the innovative technology transfer efforts fostered by the previous offices, while addressing priorities raised by the Clinton Administration's just-released National Space Transportation Policy.

Mansfield has been serving as a professional staff member on the Senate Armed Services Committee, where he was responsible for preparing budgetary and technical advice on a range of national strategic issues and programs. He previously held a number of management and technical positions related to advanced aerospace technology, including chief scientist for the Defense Advanced Research Projects Agency and assistant to the deputy director of the Defense Nuclear Agency.

Mansfield earned a doctorate in theoretical physics from Harvard University in 1970, and he has received several civil service awards.

Gregory M. Reck, who has been serving as Acting Associate Administrator for the Office of Advanced Concepts and Technology, will become Deputy Associate Administrator of the new office.

These changes are effective September 6, 1994.

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# NASA News

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Barbara Selby  
Headquarters, Washington, D.C.  
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For Release  
August 24, 1994  
4 p.m. EDT

Allen Kenitzer  
Goddard Space Flight Center, Greenbelt, Md.  
(Phone: 301/286-2806)

RELEASE: 94-138

## **NASA AWARDS INTERNET GRANTS AND COOPERATIVE AGREEMENTS**

NASA today selected 15 organizations to receive a total of \$20 million to help develop applications and technologies as a part of the Agency's efforts to provide public use of Earth and space science data over the Internet. Some of the projects are joint ventures that also will receive funding through other sources.

The remote sensing database (RSDB) applications will make the information more accessible to a wider audience than in the past. The digital library technology (DLT) projects will advance the technologies in use by digital libraries and offer new paths for the libraries of tomorrow.

These selections closely follow the Remote Sensing Public Access Center award announced Aug. 8, 1994. Additional RSDB application and DLT awards will be made in the near future.

"We look forward to working with these organizations to assist the public in accessing and using NASA remote sensing data over the Internet," said Lee B. Holcomb, NASA's Director for High Performance Computing and Communications, Washington, D.C. "They bring a wealth of diversity and talent to accelerate the creation of a National Information Infrastructure and will play a key role in developing universal access to NASA's Earth and space science products. We are particularly proud of the exciting K-12 education applications which will help prepare young people for the challenges of the 21st Century."

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The National Information Infrastructure (NII) is an effort to provide greatly improved access to electronic information and to promote the exchange of information. The endeavor seeks to enhance U.S. manufacturing competitiveness, improve electronic commerce, promote quality education, provide better government services, sustain the role of libraries, improve efficiency in environmental monitoring, and improve health care delivery with controlled costs.

The NII will permit information to be available to users anywhere in the United States, no matter where they reside. Information in Alabama, for example, can easily be referenced from Hawaii, Oklahoma, Alaska, New York, or any other part of the country.

All the projects support the NII and represent a large diversity in technical approach and application and feature several methods for retrieving, viewing and using the information. The projects will be performed in 16 states and the District of Columbia. The targeted users are teachers, students, museum visitors, tourists, scientists and the general public nationwide.

Participating schools and school districts are located in Seattle; Houston; Washington, D.C.; Fairfax, Va.; Vancouver, Wash.; the Hawaiian Islands and Grand Forks, N.D. Additional schools and school districts will be identified by several of the projects. Additionally, small or disadvantaged companies such as Camber Corp., Huntsville, Ala., and ECOlogic Corp., Washington, D.C., are included. This diversity helps to bring traditionally under-represented communities into this emerging technical arena.

The projects are part of the Information Infrastructure Technology and Applications program administered from NASA Headquarters, Washington, D.C., with technical management provided by Goddard Space Flight Center, Greenbelt, Md.

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A complete list of the grants and agreements follows.

## RSDB AND DLT GRANTS AND AGREEMENTS

A total of nine projects to develop RSDB applications are receiving funding through cooperative agreements or grants. They are:

***Athena: Curriculum Development, Implementation and Support on the Internet***, -- a \$900,000 cooperative agreement between NASA and Science Applications International Corp., Seattle. Associates include Northshore School District, Bothell, Wash.; Seattle Public Schools; Lake Washington School District, Kirkland, Wash.; Bellevue (Wash.) Public Schools; and the Office of the Superintendent of Public Instruction, Olympia, Wash. The project will develop curriculum materials integrating ocean, weather, land and space data for grades K-12.

***Bay Area Digital GeoResource (BADGER): A Model for Public/Private Shared Access to Earth Science Data Over the Internet*** -- a \$3 million cooperative agreement between NASA and Lockheed Missiles and Space Co., Research and Development Division, Palo Alto, Calif. Associates include NASA Ames Research Center, Moffett Field, Calif.; International Geomarketing Corp., Redwood City, Calif.; and the City of Mountain View, Calif. BADGER will enable local governments, utilities, businesses and the public to find, use and share data sets referenced by geological features that help them manage current responsibilities and improve the quality of their products and services.

***Earth System Science Community Curriculum Testbed*** -- a \$1.1 million cooperative agreement between NASA and ECOlogic Corp., Washington, D.C. Gonzaga High School, Washington, D.C., is an associate in this project. The effort will develop Internet access and curriculum materials for investigation-based science instruction by high school and college students.

***Enhanced Access for Forest Management Planning*** -- a \$600,000 grant to the University of Minnesota. The Minnesota Department of Natural Resources, Grand Rapids, will cooperate in this endeavor to use LANDSAT imagery, digitized aerial photography and ground-based forest databases aiding in the management of forest resources.

***Enhancing the Teaching of Science in Elementary Education Through the Application of NASA Remote Sensing Data Bases and Internet Technology*** -- a \$200,000 cooperative agreement between NASA and The Analytic Sciences Corp., Arlington, Va., with support from Franconia, Va., Elementary School and the Fairfax, Va., County School district. This project will develop weather-based curriculum for grades K-6.

***Exploring the Environment*** -- a \$1.8 million cooperative agreement with the NASA Classroom of the Future at Wheeling Jesuit College, Wheeling, W.Va. The project will develop computer software modules for use by high school students and teachers investigating Earth-science questions via extended inquiries over the Internet.

-more-

***NASA Digital Image Data Distribution for Education, Public Access and Tourism in Hawaii: A Model System*** -- a \$900,000 grant to the University of Hawaii, Honolulu. Associates are the NASA Jet Propulsion Laboratory, Pasadena, Calif.; Maui Community College, Kahului, Hawaii; Leeward Community College, Pearl City, Hawaii; and Highlands Intermediate School, Pearl City. This effort will prepare and present current data and imagery of the Hawaiian Islands over the Internet for use by the tourism industry as well as education, television and researchers.

***VOLCANOWATCH: Bringing Volcano Remote Sensing Data to Classrooms and National Parks and Monuments*** -- awarded a \$900,000 grant to the University of North Dakota, Grand Forks. Other participants include Lincoln Elementary School, Grand Forks; University of Hawaii, Honolulu; Educational Services District 112, Vancouver, Wash.; Hawaii Volcanoes National Park; and Gifford Pinchot National Forest, USDA Forest Service, Vancouver, Wash. The project will present information over the Internet covering current and historical activity of terrestrial and planetary volcanoes. Targeted audiences include visitors to Mt. St. Helens National Volcanic Monument and Hawaii Volcanoes National Park as well as grade-school students.

***Public Access to Earth and Space Science Data Via Television***, -- a \$2.2 million cooperative agreement between NASA and WRC-TV, Washington, D.C. Partners in this endeavor include the Jet Propulsion Laboratory, Pasadena, Calif.; NASA Stennis Space Center, Miss.; and the National Oceanic and Atmospheric Administration's National Weather Service, Washington, D.C. The project will develop visualizations of current Earth and space science data to be included as part of the daily weather and news reports for WRC-TV and other NBC affiliates. More importantly, the data also will be available over the Internet for use in science classes.

Six DLT projects are receiving funding to help provide for the future technologies for our libraries and research information. They are:

***Compression and Progressive Transmission of Digital Images*** -- a \$500,000 grant to the University of Wisconsin, Madison, and the Space Telescope Science Institute, Baltimore. This team will improve the rate at which large digital images can be transferred across the network.

***Creating the Public Connection: Interactive Experiences with Real-Time Earth and Space Science Data*** -- an \$800,000 grant to Rice University, Houston, in collaboration with the Houston Museum of Natural Sciences. The work will advance kiosk technology, allowing touch navigation through multi-disciplinary science data, as well as making NASA data available to all who visit the Houston Museum of Natural Sciences.

***Retrieval of Digital Images by Means of Content Search*** -- a \$2 million cooperative agreement with IBM Corp., Yorktown Heights, N.Y. The project focuses on content retrieval on compressed images.

***Test Applications and Digital Library Technologies in Support of Public Access to Earth and Space Science Data*** -- a \$2.1 million cooperative agreement between NASA and the University of Illinois, National Center for Supercomputing Applications, Urbana-Champaign. The team will develop Mosaic file format enhancements, and a Space Science and Astronomy server. Mosaic is a popular software tool used to access information on the Internet.

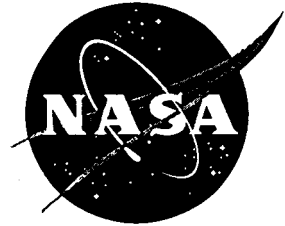
***Useability and Interoperability: A Dual Strategy for Enabling Broader Public Use of NASA's Remote Sensing Data on Internet*** -- a \$2.3 million cooperative agreement between NASA and Bellcore, Morristown, N.J., in collaboration with Camber Corp., Huntsville, Ala.; Open GIS Foundation, Cambridge, Mass.; and the Goddard Space Flight Center. The team plans to develop a virtual geodata model to enable broader public use of remote-sensing data.

***"Reaching NASA from Home - Internet Access via Cable TV"*** -- a \$700,000 cooperative agreement with Computer Sciences Corp., Calverton, Md., in collaboration with Jones Intercable, Gambrills, Md.; Integral Systems, Lanham, Md.; and the Goddard Space Flight Center. The team will develop a system to provide Internet access to the general public using channels on a local cable television connection.

# NASA News

National Aeronautics and  
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For Release

Donald L. Savage  
Headquarters, Washington, D.C.  
(Phone: 202/358-1547)

August 24, 1994

Steve Roy  
Marshall Space Flight Center, Huntsville, Ala.  
(Phone: 205/544-0034)

RELEASE: 94-139

## **NASA COMPLETES FIRST MIRROR FOR AXAF OBSERVATORY**

The first and largest of eight mirrors for the Advanced X-ray Astrophysics Facility (AXAF) has been successfully completed, and is superior in quality to any X-ray mirror ever destined for launch into space.

The mirror, designated P1, is the first of eight mirrors which will be assembled into the AXAF telescope, a large space-based observatory scheduled for launch in 1998. The prime contractor for the telescope is TRW, Redondo Beach, Calif.

The P-1 mirror will form part of the high resolution mirror assembly (HRMA), the central optical component in the AXAF 10-meter telescope. At 48 inches in diameter, the completed mirror will be the largest ever made to collect X-rays in space. The HRMA uses four pairs of precision-shaped mirrors to focus X-rays from celestial sources onto the spacecraft's imaging instruments.

Built by Hughes Danbury Optical Systems (HDOS), Danbury, Conn., the P1 mirror will be shipped to Eastman Kodak Company (EKC), Rochester, N.Y., where it will initially be used in an engineering test to verify telescope alignment processes. The P1 mirror was X-ray tested in 1991 at NASA's Marshall Space Flight Center, Huntsville, Ala. It was returned to HDOS, trimmed to final flight length, and then polished to remove distortion resulting from stress relief after trimming.

The P1 mirror's imaging quality for high energy X-rays is two times better than what was originally specified resulting in a significant improvement in its scientific capability.

- more -

Once in orbit, data from AXAF will be used to study X-ray radiation and is expected to significantly improve scientific understanding of some of the most energetic and violent processes in the universe. The observatory will produce "picture-like" images and spectrograms which will yield information on temperature and chemical composition of the objects it observes.

AXAF is designed to work in concert with NASA's Great Observatories already in orbit -- the Hubble Space Telescope (HST) and the Compton Gamma-Ray Observatory. Each observatory makes observations of stars, galaxies, and other astronomical objects in distinct and separate wavelengths of energy, including visible light, ultraviolet, gamma rays, and, in the case of AXAF, X-rays. NASA launched the HST in 1990 and in 1991 launched the TRW-built Compton Gamma Ray Observatory.

The AXAF development team consists of NASA, the Smithsonian Astrophysical Observatory, TRW, HDOS, EKC and Marshall Space Flight Center, which manages the AXAF project for NASA's Office of Space Science, Washington, D.C.

# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
202 358-1600



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For Release  
August 24, 1994

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Goddard Space Flight Center, Greenbelt, Md.  
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Jim Sahli  
Marshall Space Flight Center, Huntsville, Ala.  
(Phone: 205/544-6528)

RELEASE: 94-140

## **COMPTON GAMMA-RAY OBSERVATORY FINDS BRIGHT NEW X-RAY SOURCE**

An unusually bright X-ray source -- one of the three brightest in the sky -- has been discovered in the southern constellation Scorpius by an instrument aboard NASA's Compton Gamma-Ray Observatory. The new source, which was discovered on July 27 by the Burst and Transient Source Experiment (BATSE), has been named X-ray Nova Scorpii, or GRO J1655-40.

X-ray novae such as the one just discovered are thought to be caused by matter spilling from a normal star onto a black hole, which are collapsed stars so dense that not even light can escape them. About 10 such novae have been discovered in the past 30 years.

"We are anxious to determine whether the new source is a black hole, a pulsar (a spinning star that emits signals in short, regular bursts), or perhaps even a new type of object," said Dr. B. Alan Harmon of NASA's Marshall Space Flight Center, Huntsville, Ala. Harmon leads the research team analyzing data from a Marshall-managed BATSE instrument.

"The X-ray emission from the new source rivals that of two other dominant X-ray sources in the sky, the Crab Nebula and Cygnus X-1. The new object poses several puzzling questions for astrophysicists. For example, Nova Scorpii had an unusually rapid rise to maximum brightness, which may put significant constraints on theories of how X-rays are produced in such objects," Harmon said.

- more -

"During an X-ray nova outburst, it is thought matter from a normal star spills onto a disk of matter surrounding a companion black hole, causing the disk to heat up dramatically. How this happens, however, is not well understood, and the rapid rise to maximum brightness of Nova Scorpii adds to the mystery," Harmon said.

In addition, a property conspicuously absent in Nova Scorpii is a rapid flickering in the intensity of the source. Such flickering is typical of other X-ray novae. Scientists speculate that the lack of flickering may be because the central source that would produce it is obscured, preventing a view deep into the X-ray producing region.

Discovery of the new X-ray object has been announced to astronomers around the world so more detailed observations may be made. Another instrument on the Compton Observatory, the Oriented Scintillation Spectrometer Experiment, already has made preliminary spectral observations and obtained an improved location for the object. Meanwhile, plans are being made for other orbiting spacecraft to observe the X-ray source and a search is underway by astronomers in the Southern Hemisphere to find an optical counterpart to Nova Scorpii.

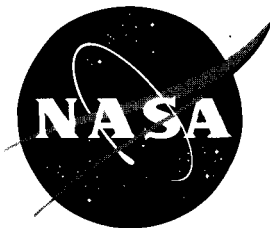
"We are especially pleased that BATSE detected the X-ray source. Now, the entire capabilities of the observatory can be used to study this new and exciting object," said Compton Observatory Project Scientist Dr. Neil Gehrels of the Goddard Space Flight Center, Greenbelt, Md.

Goddard manages the Compton Observatory for NASA's Office of Space Science, Washington, D.C. The observatory was placed into orbit around the Earth by the Space Shuttle Atlantis in April 1991.

# NASA News

National Aeronautics and  
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For Release

Ed Campion  
Headquarters, Washington, D.C.  
(Phone: 202/358-1778)

August 25, 1994

James Hartsfield  
Johnson Space Center, Houston  
(Phone: 713/483-5111)

RELEASE: C94-cc

## **JSC SELECTS LORAL TO CONTINUE SR&QA SUPPORT CONTRACT**

NASA's Johnson Space Center (JSC), Houston, has selected Loral Space Information Systems of League City, Texas, to provide support services for JSC's Safety, Reliability and Quality Assurance (SR&QA) Office under a proposed ten-year, \$299 million contract.

The anticipated contract, to be divided into a four-year base contract followed by a one-year extension option and then a five-year extension option, will provide support services in the fields of safety, reliability, maintainability, quality engineering and quality assurance. The work will be performed both at JSC and at JSC's vendor facilities.

Loral Space Information Systems, Inc., has been providing these support services to the JSC SR&QA Office under a previous contract, and this will be a continuation of those services.

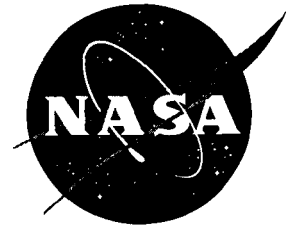
Other companies submitting proposals for the contract included Caispan Corp.'s Service Contract Division, Tullahoma, Tenn., and Martin Marietta Corp., Houston, Texas.

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# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
202 358-1600



For Release

Ed Campion  
Headquarters, Washington, D.C.  
(Phone: 202/358-1778)

August 25, 1994

Kyle Herring  
Johnson Space Center, Houston  
(Phone: 713/483-5111)

RELEASE: 94-141

## **CREW MEMBERS NAMED FOR SPACE SHUTTLE MISSION STS-70**

Air Force Colonel Terence T. (Tom) Henricks will command Space Shuttle mission STS-70 scheduled for launch in mid-1995 carrying a NASA communications satellite.

The primary payload for STS-70 is a Tracking and Data Relay Satellite used as part of a three-satellite constellation providing telecommunications needs essential to the success of Space Shuttle and low-Earth orbit spacecraft missions. Joining Henricks on the five-day mission are Kevin R. Kregel, pilot; Army Major Nancy Sherlock, mission specialist; Donald A. Thomas, Ph.D., mission specialist and Mary Ellen Weber, Ph.D., mission specialist.

Henricks, 42, has flown on two previous Shuttle missions, STS-44 in November 1991 and STS-55 in April 1993. He was born in Bryan, Ohio, but considers Woodville, Ohio, his hometown. Henricks received a bachelor of science degree in civil engineering from the U.S. Air Force Academy in 1974 and a masters degree in public administration from Golden Gate University in 1982.

Kregel, 37, was born in New York City, but considers Amityville, N.Y., his hometown. He received a bachelor of science degree in astronautical engineering from the Air Force Academy in 1978 and a masters degree in public administration from Troy State University in 1988. STS-70 will be Kregel's first Shuttle mission. He is a member of the astronaut class of 1992.

Sherlock, 35, flew as a mission specialist on the STS-57 mission in June 1993. She was born in Wilmington, Del., but considers Troy, Ohio, her hometown. Sherlock received a bachelor of arts degree in biological science from Ohio State University in 1980 and a master of science degree in safety engineering from the University of Southern California in 1985.

-more-

Thomas, 39, was a mission specialist on the STS-65 mission in July 1994. He was born in Cleveland, Ohio. Thomas received a bachelor of science degree in physics from Case Western Reserve University in 1977. He obtained his master of science and doctorate degrees in materials science from Cornell University in 1980 and 1982, respectively.

Weber, 32, was born in Cleveland, Ohio, but considers Bedford Heights, Ohio, her hometown. She received a bachelor of science degree in chemical engineering from Purdue University in 1984. Weber received her doctorate in physical chemistry from the University of California, Berkeley. She is a member of the astronaut class of 1992 and STS-70 will be her first Shuttle flight.

- end -

# NASA News

National Aeronautics and  
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202 358-1600



For Release

August 25, 1994

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Kyle Herring  
Johnson Space Center, Houston  
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RELEASE: 94-142

## **CHANG-DIAZ NAMED PAYLOAD COMMANDER FOR TSS REFLIGHT**

Veteran astronaut Franklin Chang-Diaz has been named payload commander for Space Shuttle mission STS-76 -- the second flight of the Tethered Satellite System (TSS) scheduled for early 1996.

As payload commander on the 13-day mission, Chang-Diaz, 44, will begin the necessary long-lead preparations required for TSS, which was first flown in July/August 1992 as part of the STS-46 mission. The Italian-built satellite is designed to orbit at the end of a 13-mile-long tether to test techniques for managing spacecraft at great distances and to study the electrodynamic effects of moving a conductive tether through the Earth's magnetic field.

STS-76 will be Chang-Diaz's fifth Shuttle mission. He served as mission specialist on STS 61-C in January 1986, STS-34 in October 1989, STS-46, and STS-60 in February 1994.

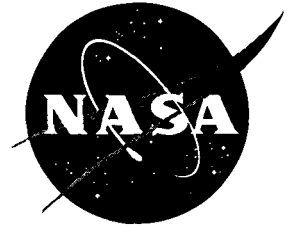
He received a bachelor of science degree in mechanical engineering from the University of Connecticut in 1973 and a doctorate in applied plasma physics from the Massachusetts Institute of Technology in 1977. He was born in San Jose, Costa Rica.

- end -

# NASA News

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202 358-1600



For Release

Barbara Selby  
Headquarters, Washington, D.C.  
(Phone: 202/358-1983)

August 25, 1994

RELEASE: 94-143

## **NASA TO USE RUSSIAN SUPERSONIC AIRLINER FOR FLIGHT TESTS**

NASA, a team of U.S. aircraft and engine manufacturers and the Russian aircraft firm, Tupolev Design Bureau, plan to use a Russian Tu-144 supersonic transport as a flying testbed for conducting flight research on high speed enabling technologies.

As part of NASA's High-Speed Research Program, the U.S. industry team, which includes Boeing, McDonnell Douglas, Rockwell International, General Electric and Pratt & Whitney, signed a contract to work with Tupolev to modify its Tu-144 aircraft to meet program research needs and to conduct up to 35 test flights.

The flights will provide unique aerodynamic, structures and operating environment data on supersonic passenger aircraft. Funding for the flight research program is being provided by NASA's Office of Aeronautics, Washington, D.C., through its Langley Research Center, Hampton, Va., in a contract with Boeing. The Tupolev effort is budgeted for \$8 million over a three-year period.

NASA first considered using the Tu-144 in September 1993 as a result of U.S.-Russian joint discussions on aeronautics. Subsequent studies by NASA, U.S. industry and Tupolev engineers concluded that because of its size, performance characteristics and availability, the aircraft would be an effective and economical flying testbed.

"Using the Tu-144 is a perfect fit between our needs and their capabilities. It's a model for cooperative technology programs with Russia," said NASA High-Speed Research Program Director Louis J. Williams. "This effort will give us up-to-date information on the 'real world' conditions that a supersonic airliner operates in -- data we wouldn't otherwise be able to obtain easily."

-more-

Personnel from NASA's Dryden Flight Research Center, Edwards, Calif., Langley Research Center and Lewis Research Center, Cleveland, will comprise the Agency's flight operations and research team carrying out the Tu-144 project.

The first flight in the research program is expected to take place by late summer of 1995.

The Tu-144 first flew in prototype form at the end of 1968. The aircraft to be used in the NASA research program is a later production version built in 1982 and has a total flight time of only 87 hours. It has a maximum cruising speed of Mach 2.35 (2.35 times the speed of sound), a range of 2,485 miles (4,000 kilometers) and a maximum altitude of 62,000 feet (18,897 meters). Tupolev most recently used the plane as a flying laboratory; it has an emergency escape system and mounts a significant number of research instruments.

The Tu-144 supersonic research program will establish direct working relationships between aircraft manufacturers in the United States and Russia and also enhance the relationship between U.S. and Russian aeronautical agencies.

-end-

NOTE TO EDITORS: A photo of the Tu-144 is available to media representatives by faxing requests to the NASA Headquarters Broadcasting and Imaging Branch on 202/358-4333. The photo numbers are: Color: 94-HC-95, 96 B & W: 94-H-99, 100

# NASA News

National Aeronautics and  
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202 358-1600



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For Release

Myron Webb  
Stennis Space Center, Miss.  
(Phone: 601/688-3341)

August 31, 1994

Ed Campion  
Headquarters, Washington, D.C.  
(Phone: 202/358-1778)

RELEASE: C94-dd

## **LOCKHEED AWARDED STENNIS SPACE CENTER CONTRACT**

NASA's John C. Stennis Space Center (SSC), Hancock County, Miss., today announced the award of a seven-year, cost-plus-award-fee contract to Lockheed Space Operations Co., Titusville, Fla., to provide propulsion test and technical services at SSC.

Lockheed had been selected by SSC in mid-July for final negotiations leading to award of the contract following an extensive competition among eight companies. Negotiations resulted in award of a contract with an estimated value of \$167,469,305 covering a 3-year base period and two 2-year options, and an estimated value of \$229,475,567 for additional labor hour options that NASA may exercise during performance of the contract. The total estimated contract value is \$396,944,872.

Lockheed will provide a broad range of test and technical services to support NASA's propulsion test programs at SSC, including the Space Shuttle Main Engine program; NASA's research and development programs in remote sensing and other space applications; and programs of other resident federal and state agencies engaged in space, oceanography and environmental research at SSC.

Other members of the Lockheed team include Cimarron Software Services Inc., Houston; Datastar Inc., Picayune, Miss.; GB Tech Inc., Houston; and Lockheed Engineering & Sciences Co., Houston.

Stennis Space Center is NASA's primary test facility for large propulsion systems and serves as the agency's lead center for commercial remote sensing programs. NASA provides technical and support services for 22 other agencies located at SSC.

-end-

# NASA News

National Aeronautics and  
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202 358-1600



For Release

James Hartsfield  
Johnson Space Center, Houston  
(Phone: 713/483-5111)

August 31, 1994

RELEASE: C94-ee

## **JSC SIGNS CONTRACT WITH PIONEER FOR LOGISTICS SERVICES**

NASA's Johnson Space Center (JSC) has signed a two-year basic period contract valued at approximately \$16.5 million with Pioneer Contract Services, Inc., Houston, to provide logistics services.

The logistics services provided by the contract include identification, cataloging, receipt and inspection of property; warehouse operations; bondroom operations; transportation support; packing and shipping and redistribution and utilization.

The two-year basic period beginning Sept. 1, 1994, will be followed by a three-year extension option. The contract value for the three-year optional period, if exercised, would be approximately \$25.5 million, making the total contract value approximately \$42 million.

Other bids for the contract were submitted by Rothe Development, Inc., San Antonio, Texas; Luis E. Garcia, Inc., San Diego, Calif.; Trend Western Technical Corp., Fullerton, Calif.; Research Management Corp., Virginia Beach, Va.; Analex Space Systems, Inc., Titusville, Fla.; Systems Management American Corp., Friendswood, Texas; and Syscom Development, Inc., Houston.

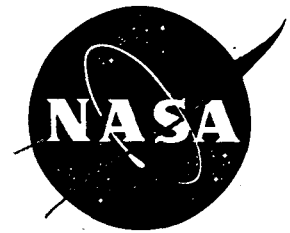
Pioneer Contract Services, Inc., had performed the same logistics services for JSC under a previous contract.

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# NASA News

National Aeronautics and  
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202 358-1600



Ed Campion  
NASA Headquarters, Washington, D.C.  
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For Release

August 31, 1994

George Diller  
Kennedy Space Center, Fla.  
(Phone: 407/867-2468)

NOTE TO EDITORS: N94-64

## **NASA MANAGERS CONDUCT READINESS REVIEW FOR STS-64**

NASA managers today conducted a Flight Readiness Review (FRR) for the upcoming launch of the Space Shuttle Discovery on the STS-64/Lidar In-Space Technology Experiment mission. During the meeting, NASA officials discussed both the processing effort on Discovery as well as the on-going analysis of the launch scrub experienced with the Shuttle Endeavour and the STS-68 mission on Aug. 18.

At the conclusion of the FRR, NASA managers deferred setting an official launch date pending closure of three issues which were left open at the end of the meeting. NASA managers expect to have all three issues resolved by early next week.

One of the issues from the STS-64 FRR is the completion of testing and analysis on the Shuttle Main Engine which caused the STS-68 launch scrub. A second issue involves the examination of cable pin connectors used on various parts of the Shuttle system. This issue came out of the failure of one cable connector to fasten properly. This is the first time this has happened and NASA managers want to verify this was an isolated incident. The final STS-64 FRR issue involves the fill/drain valves in Discovery's main propulsion system which exhibited some unusual behavior during checkout operations. Additional tests of the system are planned to verify the valves will open and close properly.

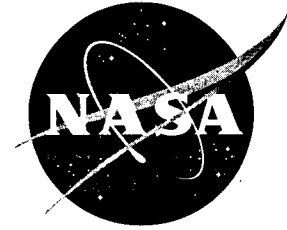
"I was very satisfied with results of the FRR," said Associate Administrator for Space Flight Jeremiah Pearson. "We have some open issues which will be thoroughly worked by the Shuttle team and we will not proceed with the launch of Discovery until they are properly resolved. Safety remains our top priority."

- end -

# NASA News

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For Release

Mark Hess  
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September 1, 1994

Kari Fluegel  
Johnson Space Center, Houston  
(Phone: 713/483-5111)

RELEASE: 94-144

## **NASA AND BOEING REACH AGREEMENT ON SPACE STATION CONTRACT**

The National Aeronautics and Space Administration and the Boeing Company today announced agreement on the key elements of the prime contract for the International Space Station.

The agreement establishes, for the first time, a joint position by NASA and its prime contractor on the scope of work, program schedule, cost ceiling and fee arrangement by fiscal year and at completion; establishes contractual terms and conditions; and clears the way for finalizing the contract before the end of the year.

Space Station Program Director Wilbur Trafton said the agreement reinforces NASA's confidence that the station will be completed on schedule and within the budget limits set by the President and ratified recently by both Houses of Congress.

Randy Brinkley, Space Station Program Manager, noted the agreement marks the third major program milestone completed on schedule this year following the System Design Review in March and the signing of a contract in June with Russia's Space Agency.

"The agreement is a testament to months of intensive effort by the joint NASA/contractor teams which have reviewed every facet of the program in search of the efficiencies and cost savings needed to keep the program on schedule and within budget," Brinkley said.

"We now have the ingredients in place, including a strong, well-defined team, to devote our attention to building the station," said Larry Winslow, Boeing Space Station Vice President. "This agreement provides the structure and direction that we all understand and can apply to the challenges ahead."

-more-

-2-

Boeing currently is operating under a letter contract signed in February. The letter contract will remain in force while remaining details are worked out on the definitized contract in the next few months.

The next major milestone for the International Space Station Program is the Interim Design Review scheduled for March 1995. Launch of the first element of the station, the FGB propulsion and control module, remains on schedule for November 1997.

-end-

# NASA News

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Headquarters, Washington, D.C.  
(Phone: 202/358-1780)

For Release

September 2, 1994

Kyle Herring  
Johnson Space Center, Houston  
(Phone: 713/483-5111)

RELEASE: 94-145

## **SPACE SHUTTLE CREW NAMED FOR SECOND MIR DOCKING MISSION**

NASA's second Space Shuttle mission to rendezvous and dock with the Russian Space Station Mir, scheduled for October 1995, will be commanded by U.S. Marine Corps Colonel Kenneth D. Cameron.

Joining Cameron on the STS-74 mission are U.S. Air Force (USAF) Lieutenant Colonel James D. Halsell, Jr., pilot, and USAF Colonel Jerry L. Ross, U.S. Army Lieutenant Colonel William S. McArthur, Jr., and Canadian Air Force Major Chris A. Hadfield.

The primary objective of the six-day flight is to attach a permanent Russian docking module to an orbiter docking system using the Shuttle's robot arm, before placing the docking module onto the Mir Space Station, where it will remain for use during future joint U.S.-Russian missions. Throughout the flight, various life sciences investigations will be performed.

Cameron, 44, has flown twice before on the Shuttle, during STS-37 in April 1991 and STS-56 in April 1993. Most recently he was NASA director of operations, Russia, where he worked with Russian trainers, engineers and flight controllers to support the training of astronauts at Star City and to enhance continued cooperation between NASA and Russia's Space Agency.

Cameron was born in Cleveland, Ohio, and received both his bachelor and master of science degrees in aeronautics and astronautics from the Massachusetts Institute of Technology in 1978 and 1979, respectively.

Halsell, 37, flew on the STS-65 mission in July and was born in Monroe, La. He received a bachelor of science degree in engineering from the Air Force Academy in 1978, a master of science degree in management from Troy University in 1983, and a master of science degree in space operations from the Air Force Institute of Technology in 1985.

-more-

Ross, 46, has flown four previous times aboard the Shuttle, during STS 61-B in November 1985, STS-27 in December 1988, STS-37 in April 1991 and STS-55 in April 1993. Ross has conducted four spacewalks on two of those missions. He was born in Crown Point, Ind., and received his bachelor and master of science degrees in mechanical engineering from Purdue University in 1970 and 1972, respectively.

McArthur, 43, flew on the STS-58 mission in October 1993. He was born in Laurinburg, N.C., and considers Wakulla, N.C., his hometown. McArthur received a bachelor of science degree in applied science and engineering from the U.S. Military Academy in 1973 and a master of science degree in aerospace engineering from the Georgia Institute of Technology in 1983.

Hadfield, 35, was born in Sarnia, Ontario, Canada, and grew up in Milton, Ontario. He received a bachelors degree in mechanical engineering from the Royal Military College, Kingston, Ontario, Canada, in 1982 and a master of science degree in aviation systems from the University of Tennessee in 1992. STS-74 will be Hadfield's first Shuttle mission. He is a member of the astronaut class of 1992.

# NASA News

National Aeronautics and  
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202 358-1600



For Release

Douglas Isbell  
Headquarters, Washington, D.C.  
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September 7, 1994

Jim Doyle  
Jet Propulsion Laboratory, Pasadena, Calif.  
(Phone: 818/354-5011)

RELEASE: 94-147

## **MAGELLAN EXECUTES 'WINDMILL' EXPERIMENT AS MISSION END DRAWS NEAR**

NASA's Magellan probe yesterday began a unique experiment designed to return data about the upper atmosphere of Venus and the behavior of a spacecraft entering it. The experiment marks the beginning of final activities for the spacecraft, which is expected to burn up in the atmosphere of Venus by October 14.

"This is the next to last act of a truly magnificent performance by Magellan and its science and operations teams," said Dr. Wesley T. Huntress, Associate Administrator for Space Science at NASA Headquarters, Washington, D.C. "Magellan has far surpassed all of its original mission goals and, in the process, revolutionized our understanding of a planet that represents what Earth might be like with a runaway greenhouse effect."

With its primary mission of mapping the surface of Venus successfully accomplished, Magellan has been used for a series of experiments that were unanticipated before its launch. In the latest maneuver, known as the "windmill" experiment, the spacecraft's wing-like solar arrays are turned in opposite directions, like windmill sails, to encounter pressure from molecules in the upper atmosphere of Venus.

The experiment is measuring how much torque will be needed to keep the spacecraft from spinning on its axis, said Project Manager Doug Griffith at NASA's Jet Propulsion Laboratory (JPL), Pasadena, Calif. These data will allow engineers and scientists to better understand basic gas-surface interactions and to gain additional aerodynamic and atmospheric data on Venus for future mission designs.

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The windmill experiment is scheduled to last until September 14. Two weeks later, more orbit trim maneuvers are scheduled to lower the spacecraft's altitude to prepare for the final termination experiment. Three further trim maneuvers will change the altitude by 5 to 6 miles (8 to 9 kilometers) each on October 10, placing the altitude of periapsis -- or closest approach to the planet -- at 96 miles (155 kilometers). The spacecraft's orbit will be lowered finally to 85 miles (136 kilometers) on October 12, with Magellan again put in a windmill attitude to collect more atmospheric data during its final entry. Gravity data acquisition will continue during all these periods up until October 10.

"After October 12, Magellan will permanently enter the atmosphere in about two days, possibly in one day," Griffith said. The atmosphere will drag the spacecraft toward the surface of the planet, but it will burn up high in the skies over Venus, he said.

There are two primary possibilities leading to NASA's final loss of contact with Magellan, Griffith said. Either the spacecraft will overheat and its communications systems will be damaged, or Magellan's control thrusters will be unable to maintain pointing control toward ground-based receiving dishes on Earth as the spacecraft spins to its demise.

In recent weeks, the performance of the spacecraft's solar arrays has begun to degrade due to the extreme temperature changes as the spacecraft passes from direct sunlight to shadow during its orbit. The thermal stress after more than five years in space and several weeks in low orbit has caused degeneration of its solar cell connections and has brought the spacecraft near the end of its useful life, Griffith said.

"It is a race to the finish," said Betsy Beyer, Magellan Program Manager at NASA Headquarters. With the continuing loss of power due to the solar cell degeneration, the spacecraft may shut down even earlier than projected, before a planned entry experiment. "Magellan has done more than its duty," Beyer said. "If it goes in its own way, instead of how we planned to end it, it is still a winner."

Controllers sent commands to Magellan in late August for orbital trim maneuvers that reduced its altitude from a near-circular orbit of 123 by 338 miles (197 by 541 kilometers) to an orbit of 107 by 242 miles (172 by 390 kilometers). These altitude reductions were required to set up conditions for the final experiment phases.

Magellan was launched in May 1989, and began mapping the surface of the planet using synthetic aperture--or side-looking--radar in September 1990. In three cycles, each comprising one Venus day or 243 Earth days, the spacecraft mapped 98 percent of the planet's surface, providing unprecedented views of its unique pancake domes of lava, strange volcanic structures, craters and high mountains.

In three subsequent cycles, it has measured Venusian gravity over 95 percent of the planet, gathering data so that scientists can map the planet's interior. Magellan also has contributed to ongoing study of the planet's massive atmosphere of carbon dioxide and high sulfuric acid clouds. This period included the first-ever "aerobraking" of a spacecraft into a near-circular planetary orbit, for Magellan's final operations.

The data which have streamed back from Magellan's radar imager, its atmospheric studies and its gravity data acquisition maneuvers have built a vast data base of new knowledge about Venus and the formation of the Solar System that will be studied by scientists for decades to come, project officials said.

JPL manages the Magellan project for NASA's Office of Space Science, Washington, D.C.

- end -

**NOTE TO EDITORS:** To illustrate this story, a variety of computer-enhanced, false-color images of Venus taken by Magellan is available to news media by faxing your request to the NASA Headquarters Broadcast and Imaging Branch on 202/358-4333.

NASA press releases and other information are available automatically by sending an Internet electronic mail message to [domo@hq.nasa.gov](mailto:domo@hq.nasa.gov). In the body of the message (not the subject line) users should type the words, "subscribe press release" (no quotes). The system will reply with a confirmation via E-mail of each subscription. A second automatic message will include additional information on the service.

# NASA News

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202 358-1600



For Release

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Headquarters, Washington, D.C.  
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September 8, 1994

Susie Marucci  
Headquarters, Washington, D.C.  
(Phone: 202/358-1896)

RELEASE: 94-148

## **NASA ON-LINE SYSTEM SPEEDS UP MIDRANGE PROCUREMENTS**

A new on-line system available over the Internet is speeding up the way one NASA center does its MidRange procurements and ultimately should save substantial amounts of time compared to traditional, non-electronic methods.

Instead of relying on hard copies of information available from NASA's Marshall Space Flight Center, Huntsville, Ala., interested companies can now view and download relevant information quickly and easily from their offices.

NASA's MidRange, a simplified procedure for procurements between \$25,000 and \$500,000, was approved on a test basis at Marshall by the Office of Federal Procurement Policy. The test has been in effect at Marshall since July 1993, and is planned to last four years. It has proven so successful that NASA recently began expanding the program to other NASA centers, which should be using MidRange by October 1994.

Approximately 80 percent of all NASA's contract actions--accounting for 11 percent of contract dollars--fall into the MidRange category. Streamlined solicitations and contracts, MidRange buying teams, best value selection, and the use of the on-line system to announce opportunities and disseminate solicitations are all part of the MidRange procurement process.

One of the highlights of this program is the Marshall Procurement Home Page, which lists upcoming procurements, solicitations, and other items of interest for businesses interested in working with Marshall. While NASA will continue to provide information to the Commerce Business Daily, as required by law, the same information and the solicitation and model contract are available from Marshall via the Internet. Other centers are beginning to add their information as well.

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-2-

The Marshall MidRange information can be found on the World-Wide Web on "<http://procure.msfc.nasa.gov>".

For more information, contact Jim Bradford at Marshall, 205/544-0306, e-mail address, [jim.bradford@msfc.nasa.gov](mailto:jim.bradford@msfc.nasa.gov); Michael Lalla at 205/544-3948, e-mail address, [michael.lalla@msfc.nasa.gov](mailto:michael.lalla@msfc.nasa.gov); or Tom Deback at NASA Headquarters, 202/358-0431, e-mail address, [tdeback@proc.hq.nasa.gov](mailto:tdeback@proc.hq.nasa.gov).

-end-

NASA press releases and other information are available automatically by sending an Internet electronic mail message to [domo@hq.nasa.gov](mailto:domo@hq.nasa.gov). In the body of the message (not the subject line) users should type the words, "subscribe press-release" (no quotes). The system will reply with a confirmation via E-mail of each subscription. A second automatic message will include additional information on the service.

# NASA News

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For Release

Donald Savage  
Headquarters, Washington, D.C.  
(Phone: 202/358-1547)

September 8, 1994

Jim Doyle  
Jet Propulsion Laboratory, Pasadena, Calif.  
(Phone: 818/354-5011)

RELEASE: 94-149

## **NASA SELECTS MARS PATHFINDER LANDING SITE**

NASA has selected an ancient flood plain on Mars as the landing site for the 1997 mission of Mars Pathfinder, one of the first in a new generation of small, low cost spacecraft.

Eons ago, when water flowed on Mars, great floods inundated the landing site, located on a rocky plain in an area known today as Ares Vallis. The site is 527 miles (850 kilometers) southeast of the location of Viking Lander 1, which in 1976 became the first spacecraft to land on Mars. Pathfinder will be the first spacecraft to land on Mars since the twin Viking landers arrived almost 20 years ago.

The spacecraft, scheduled to arrive at Mars on July 4, 1997, will parachute down to Ares Vallis at the mouth of an ancient outflow channel chosen for the variety of rock and soil samples it may present.

The purpose of the new Pathfinder mission is to demonstrate an inexpensive system for cruise, entry, descent and landing on Mars, said Project Manager Anthony Spear and Project Scientist Dr. Matthew Golombek of NASA's Jet Propulsion Laboratory (JPL), Pasadena, Calif.

The lander, carrying a microrover, will aerobrake in the upper Martian atmosphere using an aeroshell and a parachute. Just before impact, airbags will inflate to cushion the landing. The microrover will then roll out to examine the rocks and soil nearby.

Both lander and rover will carry scientific instruments and cameras. The lander will make atmospheric and meteorological observations during descent and function as a weather station on the surface, as well as a radio relay station for the rover.

- more -

The constraints on the landing site location have to do with engineering considerations, Spear said. Since the spacecraft are solar-powered, the best site is one with maximum sunshine and in July 1997, the Sun will be directly over the 15 degrees north latitude region of the planet.

The elevation must be as low as possible, Spear added, so the descent parachute has sufficient time to open and slow the lander to the correct terminal velocity. The landing will be within a 60- by 120-mile (100- by 200-kilometer) ellipse around the targeted site due to uncertainties in navigation and atmospheric entry.

Ares Vallis, which meets the engineering constraints, was chosen after a workshop earlier this year that involved the invited participation of the entire Mars scientific community. More than 60 scientists from the United States and Europe attended.

The Ares Vallis site also is a "grab bag" location, according to Golombek, located at the mouth of a large outflow channel in which a wide variety of rocks are potentially within the reach of the rover. Even though the exact origins of the samples would not be known, he said, the chance of sampling a variety of rocks in a small area could reveal a great deal about Mars.

The rocks would have been washed down from highlands at a time when floods moved over the surface of Mars. Several potential sites were listed where ancient flood channels emptied into Chryse Planitia, having cut through crustal units and ridged plains where the water would have picked up material and deposited it on the plain.

Other sites that were considered included Oxia Palus, a dark highlands region that contains highland crust and dark wind-blown deposits; Maja Valles Fan, a delta fan which drained an ancient outflow channel; and the Maja Highlands, just south of Maja Valles. All of the sites were studied using Viking orbiter data.

Both the Pathfinder lander and rover have stereo imaging systems. The rover carries an alpha proton X-ray spectrometer that will enable examination of the composition of the rocks. The imaging system will reveal the mineralogy of surface materials as well as the geologic processes and surface-atmosphere interactions that created and modified the surface. The instrument package also will enable scientists to determine dust particle size and water vapor abundance in the atmosphere.

-3-

JPL manages the Mars Pathfinder mission for NASA's Office of Space Science, Washington, D.C.

-end-

**NOTE TO EDITORS:** A Viking photograph of the landing site is available to news media representatives by faxing your request on letterhead to the Headquarters Broadcast and Imaging Branch, 202/358-4333. Photo numbers are: color: 93-HC-405, 93-HC-406, 93-HC-407; and B&W: 93-H-449, 93-H-450, 93-H-451, 94-H-239. In addition, a 9-minute video animation is available by fax request at the same number.

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# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
202 358-1600



For Release

Barbara Selby  
Headquarters, Washington, D.C.  
(Phone: 202/358-1983)

September 9, 1994

Lori Rachul  
Lewis Research Center, Cleveland, Ohio  
(Phone: 216/433-8806)

RELEASE: 94-150

## **NASA AWARDS HIGH-SPEED PROPULSION CONTRACT**

As part of the High-Speed Research Program, NASA has signed a \$266 million contract with the industry team of GE Aircraft Engines and United Technologies' Pratt & Whitney for work on the critical propulsion component technologies for a 21st century High-Speed Civil Transport (HSCT).

The goal of NASA's High-Speed Research Program is to conduct research that can produce a future supersonic airliner that will be environmentally friendly and will carry passengers at air fare costs very close to that of subsonic airliners.

GE Aircraft Engines, Cincinnati, Ohio, and Pratt & Whitney, East Hartford, Conn., will work together to develop the technology required for the key propulsion components -- ultra-low nitrogen oxide (NOx) combustors, low-noise exhaust nozzles, mixed-compression inlets and low-noise fans.

The eight-year, cost-reimbursement contract will be managed by NASA's Lewis Research Center, Cleveland. The work will be performed at the GE Aircraft plant in Cincinnati; Pratt & Whitney facilities in West Palm Beach, Fla., and East Hartford; and NASA Lewis. Work is already being performed under a letter contract signed in June 1994. This action definitizes that letter contract.

Other companies supporting the GE/Pratt & Whitney team include Boeing Commercial Airplane Group, Seattle; McDonnell Douglas Aerospace, Long Beach, Calif.; and Allison Gas Turbine Division, General Motors Corp., Indianapolis.

-more-

-2-

The Critical Propulsion Components (CPC) program will use the results of previous and ongoing High-Speed Research propulsion system work to focus this technology program on the most promising engine concepts and on the key technology needs of the HSCT.

The key to a viable future supersonic airliner or HSCT is the propulsion system. The CPC program will provide a technical foundation that the nation's aerospace companies can use to make intelligent business decisions regarding HSCT.

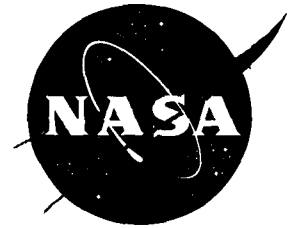
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# NASA News

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202 358-1600



For Release  
September 12, 1994

Mark Hess/Ed Campion  
Headquarters, Washington, D.C.  
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Janet Dean  
Rockwell International, Downey, Calif.  
(Phone: 310/922-5227)

RELEASE: 94-151

## **SHUTTLE/MIR DOCKING HARDWARE ARRIVES FROM RUSSIA**

NASA's prime contractor for Space Shuttle orbiters, Rockwell Aerospace, took delivery Sunday of the Russian built spacecraft docking mechanism that will enable Space Shuttle Atlantis to join up with the orbiting Russian Mir Space Station next June.

Rockwell procured the docking hardware a year ago from NPO Energia for approximately \$18 million, along with spare parts and technical services to support NASA's first Shuttle mission to Mir. The docking mechanism, called the Androgynous Peripheral Docking Assembly (APDA) was shipped September 8 from the Energia Production Facility in Kaliningrad, near Moscow.

Work will begin immediately at Rockwell's Space Systems Division (SSD) to assemble the APDA with the Rockwell-built docking system hardware. The APDA will be mated onto a docking base that attaches to a new external airlock designed to fit in the front of the orbiter payload bay supported by a truss structure. The external airlock connects with the existing airlock inside the crew cabin and with a Spacelab module.

In December, following integrated checkout at Rockwell, the Shuttle/Mir docking system will be delivered to Kennedy Space Center, Fla. There it will be installed aboard the Atlantis, which earlier this year completed a series of modifications that will allow it to accommodate the new docking system.

- more -

For the STS-71 mission to the Russian Space Station, scheduled for May 1995, Atlantis will carry a crew of five American astronauts and two Russian cosmonauts, along with approximately 1,100 pounds of equipment for use on Mir.

Two days into its flight, Atlantis will dock with Mir, whose crew of two cosmonauts and NASA astronaut Norm Thagard will have been aboard for 90 days following an earlier launch in a Russian Soyuz-TM capsule. The Atlantis and Mir crews will conduct five days of joint medical research on the physiological effects of extended space flight. The original Mir crew, including Thagard, will then join the Atlantis' astronauts for the trip back to Earth, while the two new cosmonauts will remain aboard for a long duration stay.

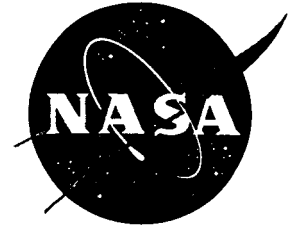
The STS-71 mission is the first of seven to ten Space Shuttle missions to Mir that are planned under a cooperative agreement between NASA and the Russian Space Agency (RSA). A \$400 million contract recently signed by the agencies provides funding to Russia for activities under the protocol to the Human Space Flight Agreement which was signed in December 1993. The contract provides for Russian hardware, services and data in support of a joint program involving the U.S. Space Shuttle and the Russia's Mir Space Station and selected requirements for the International Space Station.

Rockwell SSD is prime contractor to NASA for Space Shuttle orbiters. The company also is under contract to NASA for support to the Shuttle/Mir missions. NPO Energia is an advanced technology organization responsible for the design and manufacture of the Energia launch vehicle and manned systems including the Soyuz-TM and Progress-M spacecraft, the Mir Space Station and the Buran Space Shuttle. Energia originally developed the APDA for Buran/Mir missions. Rockwell and Energia provided docking hardware for the Apollo/Soyuz Test Project in July 1975.

# NASA News

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202 358-1600



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For Release

Donald Savage  
Headquarters, Washington, D.C.  
(Phone: 202/358-1547)

September 14, 1994

RELEASE: 94-152

## **NASA SELECTS TWO SMALL EXPLORER MISSIONS FOR DEVELOPMENT**

Two new science missions to study the Sun and the evolution of galaxies, both aboard small, relatively inexpensive spacecraft, were unveiled today by Dr. Wesley T. Huntress, NASA Associate Administrator for Space Science.

The first of the newly selected missions, the Transitional Region and Coronal Explorer, or TRACE, will observe the Sun to study the connection between its magnetic fields and the heating of the Sun's corona. Dr. Alan Title of the Lockheed Palo Alto Research Laboratory, Calif., is the principal investigator. His team will include 13 other scientists from the United States, Sweden, the United Kingdom and the Netherlands. TRACE is scheduled for launch in 1997.

The second spacecraft, the Wide-Field Infrared Explorer, or WIRE, is scheduled for launch in 1998 on a mission to study the evolution of galaxies. WIRE will use a cryogenically-cooled telescope and arrays of highly sensitive infrared detectors for the studies. WIRE was proposed by Dr. Perry B. Hacking of NASA's Jet Propulsion Laboratory, Pasadena, Calif., with co-investigators from the California Institute of Technology, Cornell University, Ball Aerospace Systems Group, and JPL.

The two newly announced missions are part of NASA's Small Explorer (SMEX) Program, which provides frequent flight opportunities for highly focused and relatively inexpensive science missions. Small Explorer spacecraft weigh approximately 500 pounds (227 kilograms). Each mission is expected to cost approximately \$50 million for design, development and operations through the first 30 days in orbit.

- more -

The missions will be launched by Pegasus, an expendable launch vehicle owned and operated by Orbital Sciences Corp., Loudon, Va., under contract to NASA. The TRACE and WIRE missions join three other Small Explorer missions already in development or operation.

SAMPEX, the Solar, Anomalous and Magnetospheric Particle Explorer, was launched July 3, 1992 and has been successfully investigating the composition of local interstellar matter and solar material, and the transport of magnetospheric charged particles into the Earth's atmosphere.

The Submillimeter Wave Astronomy Satellite, or SWAS, is scheduled for launch in June 1995 on a Pegasus rocket to be released from an L-1011 at NASA Goddard Space Flight Center's Wallops Flight Facility in Virginia. SWAS will for the first time directly measure the amount of water and molecular oxygen in interstellar clouds. SWAS also will measure carbon monoxide and atomic carbon, which are believed to be major reservoirs of carbon in these clouds.

FAST, the Fast Auroral Snapshot Explorer, is scheduled for launch one month after SWAS, in July 1995, from Vandenberg Air Force Base in Lompoc, Calif. FAST will probe the physical processes that produce aurorae, the displays of light that appear in the upper atmosphere at high latitudes.

Mission definition, development and launch of the Small Explorer Program are managed by the Small Explorer Project Office, Goddard Space Flight Center, Greenbelt, Md., for NASA's Office of Space Science, Washington, D.C.

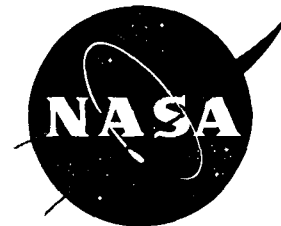
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# NASA News

National Aeronautics and  
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202 358-1600



For Release  
September 15, 1994

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Bruce Buckingham  
Kennedy Space Center, Fla.  
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Release: 94-153

## **RUNWAY RESURFACING STARTS FOLLOWING CV-990 TESTS**

NASA has begun resurfacing the runway at the Kennedy Space Center, a move that will improve the wear on Shuttle tires and potentially lead to an expansion of the Return to Launch Site landing crosswind flight rule.

Raising crosswind limits from the current constraint of 15 knots would increase launch probabilities from the spaceport on Florida's Atlantic coast. A small increase could substantially reduce the days in which crosswinds are too high for orbiters to land back at the Shuttle runway at Kennedy if an emergency occurred immediately after launch.

The runway resurfacing also will improve safety for end of mission landings at KSC.

The resurfacing follows a series of successful tests with Space Shuttle tires and a new runway resurfacing technique using NASA's CV-990 Landing Systems Research Aircraft (LSRA).

"Shuttle launches involve complicated choreography," said Space Shuttle Operations Director Brewster Shaw. "This includes not only the conditions that apply to launching out of the atmosphere and into space, but also weather and winds at several locations around the world in case problems force us to make an immediate landing. By raising the Shuttle crosswind limits, something we have studied in a very conservative and methodical way, we can enhance our capability to launch on a given day."

-more-

The LSRA is highly modified to duplicate the landing weight, speed and side slip of the Space Shuttle. The converted jetliner carries a landing gear test fixture that can test orbiter tires at up to 140,000 lbs. of load. It was originally developed as a Space Shuttle landing systems testbed, but can be used to test a variety of aircraft landing systems. The LSRA was developed and is operated by NASA's Dryden Flight Research Center, Edwards, Calif.

During the latest series of testing at Kennedy, the LSRA team studied three different runway surfaces to determine the best landing conditions for the orbiter. A resurfacing technique using a Skidabrader machine was chosen and the entire 15,000-foot runway at Kennedy will be resurfaced.

The runway surface treatment machine, which looks like an ice rink resurfacing vehicle, propels tiny steel shot onto the runway to pulverize the rough surface and create a much smoother finish.

These tests are part of a comprehensive effort by the Shuttle program to evaluate crosswind limits under which an orbiter can safely land. Tests with the CV-990 complement data which is being collected during actual Space Shuttle landing approaches. These data are being used to obtain a better understanding of orbiter handling characteristics at landing speeds in various crosswind conditions.

"If we can save the Shuttle program eight days of delay we will have paid for the entire LSRA program," said Christopher Nagy, chief CV-990 engineer. The cost to modify the aircraft into a test facility and operate it through this fiscal year was \$12 million.

"The orbiter and all of its systems, with the exception of the tires, were designed and built to handle a 20-knot cross wind," said Robert Baron, CV-990 program manager. "During the tests to certify them up to 20 knots of crosswind, we hit tire loads of up to 140,000 lbs...way above their design limits...and they held up consistently beyond their rated capacities."

According to Baron, no changes are required to the tires to increase their crosswind limits.

The CV-990 logged 26 flights during the most recent phase of testing at Kennedy, bringing the total to 101 flights since the aircraft was modified into a test facility. Along with improving orbiter landing capabilities, the CV-990 test team produced data to help update Space Shuttle simulators used by NASA's Johnson Space Center, Houston, and Rockwell International.

The CV-990 project pilot is Gordon Fullerton, who flew on two Space Shuttle missions before leaving the astronaut corps in 1986 to become a research pilot at Dryden.

Although testing at the Kennedy Space Center is complete, additional flights are planned at Edwards to test Shuttle tires at low air pressures and on the lakebed.

According to Baron, CV-990 project personnel are exploring possible programs with other government agencies to utilize the unique test and research capabilities of the aircraft.

Participants in the Space Shuttle tire testing and CV-990 programs include the Johnson Space Center; Kennedy Space Center; the Landing Impact Dynamics Facility, NASA Langley Research Center, Hampton, Va.; Landing Gear Development Facility, Wright-Patterson AFB, Ohio; B.F. Goodrich Facility, Troy, Ohio; and Rockwell International's Space Transportation Systems Division, Downey, Calif.

- end -

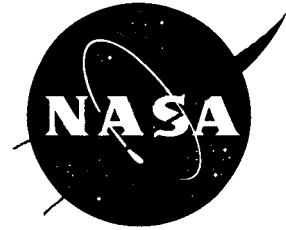
**Editors Note:** Photographs of the CV-990 tests can be obtained by calling the Dryden Flight Research Center Public Affairs Office. The photo numbers are : EC92 05275-30, EC92 12221-1, EC92 12221-2, EC93 41018-5, EC93 41018-6, EC93 41018-18. These photos also are available via Internet by sending a message to: [http://www.dfrf.nasa.gov/photo\\_server/photo\\_server/html](http://www.dfrf.nasa.gov/photo_server/photo_server/html).

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202 358-1600



For Release

Michael Braukus  
Headquarters, Washington, D.C.  
(Phone: 202/358-1979)

September 19, 1994

Diane Ainsworth  
Jet Propulsion Laboratory, Pasadena, Calif.  
(Phone: 818/354-5011)

RELEASE: 94-156

## **NASA TECHNOLOGY SUPPORTS NEW MEDICAL INFORMATION SUPERHIGHWAY**

High-speed information technologies developed by NASA can support physicians in remote locations on a new medical information superhighway by providing them instant access to information and treatment strategies for their patients.

The new, integrated computing and telecommunications technologies developed by NASA's Jet Propulsion Laboratory, Pasadena, Calif., will be demonstrated Sept. 20 before members of Congress and the Clinton Administration by the National Information Infrastructure Testbed, a non-profit consortium of corporations, universities and government agencies committed to translating the vision of a national information infrastructure into reality.

"Right now, a revolution in the way we plan and deliver medical care is knocking on our door, and NASA's going to be in the front ranks of that revolution," said NASA Administrator Daniel S. Goldin. "We'll merge our unique skills with those of the other major players to create innovative technology and engineering solutions."

The demonstration will take place at 10 a.m. EDT in the foyer of the Rayburn House Office Building, Independence Avenue entrance.

The "telemedicine" demonstration shows how ground and satellite communications and supercomputing technologies can be applied to improve the delivery of critical medical care and expertise to geographically dispersed sites throughout the country.

-more-

The demonstration will simulate an emergency trauma situation in which a patient on vacation in a remote area of the Southern California desert is badly injured in an automobile accident. Satellite communications will be used to allow a rural hospital to communicate with trauma specialists at the University of Southern California (USC) Medical Center in Los Angeles.

"Using this communications network, the patient's medical records could be remotely accessed while critical medical images would be shared by specialists in diagnosing the patient's medical condition," said Edward Chow, technical manager of the telemedicine demonstration at JPL. "Real-time consultation could be carried out by teleconferencing and the patient could receive an agreed-upon treatment."

"This demonstration illustrates the many ways in which technologies developed for the space program can be harnessed to enrich the lives of people," said JPL Director Dr. Edward C. Stone, who will participate in a panel discussion of the telemedicine demonstration.

The health care consortium will point out the potential benefits of the networking technology to improve the quality and delivery of medical services, including:

- Improved analysis tools to prevent expensive and sometimes unnecessary medical procedures;
- Timely delivery of lab results and expedient treatment;
- Improved collaboration of primary and specialized health care physicians using new, high-speed data communications techniques;
- Extending quality health care to underserved and unserved areas of the country.

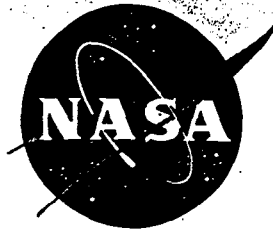
Participants in the telemedicine demonstration will include AT&T, Hewlett-Packard, Hughes Aircraft Corporation, IBM, Johns Hopkins Medical Center, Lawrence Livermore National Laboratories, NASA-JPL's Telecommunications Systems Division, Network Systems Corporation, Pacific Bell, Polaroid Corporation, Sandia National Laboratories, SynOptics Communications, WilTel, USC Medical Center and the USC Advanced Biotechnical Consortium.

JPL's work in the telemedicine demonstration is sponsored by NASA's Office of Life and Microgravity Sciences and Applications; the Office of Space Access and Technology; and the Office of Space Science, Washington, D.C.

# NASA News

National Aeronautics and  
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202 358-1600



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Brian Dunbar  
Headquarters, Washington, D.C.  
(Phone: 202/358-1547)

For Release  
September 20, 1994

Michael Finneran  
Goddard Space Flight Center, Greenbelt, Md.  
(Phone: 301/286-5565)

RELEASE: C94-ff

## **GENERAL SCIENCES SELECTED FOR \$31 MILLION CONTRACT NEGOTIATION**

General Sciences Corp., Laurel, Md., has been selected by NASA to negotiate a 1-year basic-period and nine 1-year options-period contract that will support a key instrument for NASA's Earth Observing System (EOS).

The proposed cost-plus-award-fee \$31 million contract will provide support services for two Moderate Resolution Imaging Spectroradiometer (MODIS) science support teams: the MODIS Characterization Support Team and the Science Data Support Team for the Earth Sciences Directorate at the Goddard Space Flight Center, Greenbelt, Md. The MODIS instrument is a critical element of the agency's Mission to Planet Earth program and is scheduled to fly on at least three EOS spacecraft.

The contract period will begin in mid-October 1994 and continue through October 1995. One other company, Hughes STX Corp. in Lanham, Md., submitted a proposal for the contract.

- end -

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National Aeronautics and  
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202 358-1600



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For Release

Brian Dunbar  
Headquarters, Washington, D.C.  
(Phone: 202/358-0873)

September 20, 1994  
10 a.m. EDT

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Martin Marietta Astro Space, East Windsor, N.J.  
(Phone: 609/490-6991)

RELEASE: 94-157

## **INVESTIGATION PANEL RELEASES REPORT ON NOAA-13 FAILURE**

The probable cause of the failure of the National Oceanic and Atmospheric Administration-13 (NOAA-13) meteorological satellite in August 1993 was a short circuit that prevented the solar array current from powering the spacecraft and recharging the batteries, according to a 12-member investigating board, whose report was released today.

In a 36-page report, the board indicated that the failure most likely occurred in a battery charge assembly on the spacecraft. Based on telemetry from the satellite, the board indicated the most probable cause was a 1.25-inch screw that extended too far below an aluminum plate designed to dissipate heat. The screw end penetrated the insulation and made contact with a radiator plate, causing the short circuit.

The short circuit effectively prevented the solar arrays from powering the spacecraft, forcing the spacecraft to rely on its batteries, according to the board's findings. Without power from the solar arrays, the batteries could not recharge and exhausted their power, leaving the satellite with no power to operate its instruments or to communicate with the ground.

- more -

"The board concluded that the design of the charge assembly is prone to a failure of this type," said Jeremiah Madden of NASA's Goddard Space Flight Center, Greenbelt, Md., who chaired the board. "The design requires meticulous construction procedures, and there are many areas where a short could occur."

The board termed the design of the battery charge assembly "unforgiving," indicating that "it cannot be checked once it is assembled since the heat sink cannot be removed or easily X-rayed."

Launched into a 540-mile (870-kilometer) near polar orbit on an Atlas rocket from Vandenberg Air Force Base, Calif., on August 9, 1993, the \$77 million spacecraft operated normally until August 21. During orbit 175, 12 minutes after the satellite's last communication with the NOAA Command and Data Acquisition site at Wallops, Va., the short circuit occurred, the board found.

When controllers communicated with the satellite and found it operating normally on orbit 175, they followed standard procedures and turned their attention to other operational satellites. Controllers did not communicate with NOAA-13 again until orbit 177. At that point the operations crew noted battery low voltage and high temperature flags on all three batteries, which were the first indications of a problem, the board reported.

Controllers were unable to acquire a signal from the spacecraft on orbit 178, the board noted, and orbits 179 and 180 were not monitored because the spacecraft did not pass over either the ground station at Wallops or the other ground station monitoring the satellite at Fairbanks, Alaska.

On orbit 181, satellite recovery procedures were started; however, no further signals from the satellite were received.

In reaching its conclusion as to probable cause, the board looked at hardware being used to build NOAA-J, the next spacecraft in the NOAA series, targeted for launch in December. The team compared 12 relay mounting screws from the stock used for NOAA-J, with dimensions of the NOAA-J relay mounting.

The team found that 10 of the 12 screws were long enough to penetrate into the insulation layer on NOAA-J, lending "credence to the possibility that the failure on NOAA-13 was due to such a screw," the board reported.

The team reported that a "major contributor" to the failure was the "poor packaging design" of the battery charge assembly heat sink plate "that allows numerous places for shorts, requires unique insulation schemes and demands tightly controlled careful assembly."

Another major contributor reported by the board was "poor processing and inspection" of the charge assembly. There was no procedure, the board indicated, that underlined the importance of "making sure nothing protrudes beyond the bottom of the heat sink. The inspection seemed to be the responsibility of the technician that puts the unit together rather than that of an inspection by a quality assurance engineer," the board concluded.

Although there was a specific manufacturing instruction to check the box for protrusion, "the quality control plan for building the BCX box (battery charge assembly box) was inadequate," according to the team. "There were not enough checks performed on the unit as it was being built. The procedures were not adequate to inform the technician of the criticality of the unit and to give him specific instructions on how to check his work."

The team attributed the lack of inspection partially to the repeated successful flights of this BCX design. "The use of previously flown hardware tends to lessen the overview it receives," the board suggested. "This unit's heritage goes back to at least 1972. The first assembly technicians were probably extremely careful and understood the criticality of the design; however, in time and with personnel changing, there was probably some loss of knowledge and awareness."

The board made 21 recommendations for future NOAA spacecraft, included as appendices to the report. The recommendations included a thorough review of and modification to elements of the spacecraft's power system, closer monitoring of work in process by experienced personnel, modification of the heat sink in the battery charge assembly and improvements in some of the spacecraft's software.

Among the specific points the board made were recommendations for high-voltage tests to verify the insulation and the incorporation of software that would reduce power consumption if on-board computers were to detect low battery charges. All of the board's recommendations regarding the NOAA spacecraft are being implemented by the project office.

The failure team also recommended that NOAA upgrade its ground stations so that health and safety telemetry may be taken from operational satellites during every orbit. NOAA officials have committed to adopting all of the board's recommendations as soon as practicable, said Gary Davis, Deputy Director of Satellite Operations for NOAA.

To correct the NOAA-13 deficiencies on the NOAA-J spacecraft, modifications in the area where the failure most probably occurred have been made, according to Charles Thienel, Associate Director of Flight Projects for Meteorological Satellites at NASA's Goddard Space Flight Center.

The modifications addressed all of the potential failure causes mentioned in the report. Most importantly, the radiator plate in the charge assembly is no longer "hot," or carrying electric current. Even if a screw were to touch the plate, as may have happened on NOAA-13, there would be no short circuit.

Moreover, he said, additional inspections and tests were implemented on NOAA-J. The project team also has developed flight software that will allow ground controllers more time to deal with a power-system problem by isolating a short circuit, effectively removing the affected subsystem from the spacecraft's power system.

Also, Thienel explained, an exhaustive review was undertaken on NOAA-J by an independent team to look carefully at every spacecraft system and subsystem. The review will verify that all inspections and tests were carried out to demonstrate compliance with the mission requirements.

The NOAA prime contractor and builder, Martin Marietta Astro Space, East Windsor, N.J., in addition to making the specific changes recommended by the NOAA-13 board, has undertaken intensive reviews of the design, manufacture and testing of every satellite it is building. For NASA, these satellites include the Landsat 7 and EOS-AM1 Earth-observing spacecraft and the Wind and Polar space science missions.

Failure team members were Jeremiah J. Madden, Associate Director of Flight Projects, Goddard Space Flight Center (GSFC), Chairman; James Murphy, Flight Projects Directorate (GSFC), Recording Secretary; H. Richard Freeman, Chief Engineer, Engineering Directorate (GSFC); John Pandelides and Donald Lokerson, Flight Projects Directorate (GSFC); Edward Gaddy, Engineering Directorate (GSFC); Alfred L. Seivold, Flight Assurance Directorate (GSFC); Thomas E. McGunigal, Systems Acquisition Office, NOAA; Gary Davis, National Environmental Satellite, Data and Information Service, NOAA; James Greaves, Office of Mission to Planet Earth, NASA Headquarters; Michael Greenfield, NASA Headquarters and William J. Middendorf, NASA Lewis Research Center, Cleveland, Ohio.

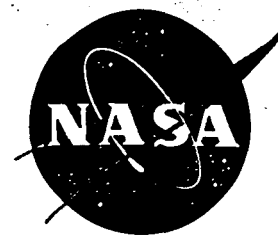
F. John Solman III and Angelo Colao, of the Massachusetts Institute of Technology (MIT), Cambridge, Mass., served as consultants to the board, and Josef Wonsever, NASA Headquarters, David Coolidge, Flight Projects Directorate (GSFC), and Wilfred Mazur, NOAA, served as advisors to the panel.

NOAA's polar-orbiting satellite program is a cooperative effort with NASA. The space agency's Goddard Space Flight Center develops and procures the spacecraft before turning them over to NOAA for operations. Copies of the NOAA-13 failure report are available in the newsrooms at NASA Headquarters, Goddard Space Flight Center, Johnson Space Center and Kennedy Space Center.

# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
202 358-1600



For Release

Douglas Isbell  
Headquarters, Washington, D.C.  
(Phone: 202/358-1753)

September 20, 1994

James H. Wilson  
Jet Propulsion Laboratory, Pasadena, Calif.  
(Phone: 818/354-5011)

RELEASE: 94-158

## **ASTEROID MOON DISCOVERED BY GALILEO SPACECRAFT IS NAMED**

The International Astronomical Union (IAU) has approved the name Dactyl for the tiny moon discovered this year in orbit around the asteroid Ida by NASA's Galileo mission.

The IAU also approved names for surface features on another asteroid, Gaspra, which became the first asteroid ever visited by a spacecraft when Galileo flew by it on Oct. 29, 1991.

Dactyl is the first natural satellite of an asteroid ever discovered and photographed. The tiny moon, about one mile (1.5 kilometers) across, appeared in images obtained by the Galileo spacecraft during its flyby of the asteroid on Aug. 28, 1993.

Dactyl was discovered in data analyzed in March 1994 by members of Galileo's imaging and infrared science teams. The project recommended the name to the IAU, which is responsible by international agreement for the formal naming of Solar System bodies.

The name is derived from the Dactyli, a group of mythological beings who lived on Mount Ida, where the infant Zeus was hidden -- and raised, in some accounts -- by the nymph Ida and protected by the Dactyli. Other mythological accounts say that the Dactyli were Ida's children by Zeus.

Three regions on Gaspra were named for scientists associated with the asteroid. Neujmin Regio was named for G. Neujmin, the Ukrainian astronomer who discovered the asteroid in 1916. Yeates Regio honors the late Dr. Clayne M. Yeates, who was Galileo Science Manager and Science and Mission Design Manager until his death in 1991. Dunne Regio was named in honor of the late Dr. James A. Dunne, who served as Galileo Science and Mission Design Manager until late 1992.

-more-

-2-

"Clayne Yeates and Jim Dunne both contributed immensely to the Galileo project and to the Gaspra encounter in particular," said Galileo Project Manager William J. O'Neil at NASA's Jet Propulsion Laboratory (JPL), Pasadena, Calif.

The surfaces of Gaspra and Ida are covered with impact craters like those on Earth's Moon. Gaspra was named by Neujmin for a resort on the Crimean peninsula. Consequently, many of the asteroid's craters have been named for resorts and spas worldwide.

The Galileo spacecraft is on its way to Jupiter, where it will send a probe into the atmosphere on Dec. 7, 1995, and then go into orbit for a two-year scientific tour of the planet, its satellites and its magnetosphere. JPL manages the Galileo project for NASA's Office of Space Science, Washington, D.C.

- end -

**NOTE TO EDITORS:** Color and black and white images of Dactyl are available to news media by faxing your request to the NASA Headquarters Broadcast and Imaging Branch on 202/358-4333. Photo numbers are: 94-HC-160 and 94-H-170.

*NASA press releases and other information are available automatically by sending an Internet electronic mail message to [domo@hq.nasa.gov](mailto:domo@hq.nasa.gov). In the body of the message (not the subject line) users should type the words "subscribe press-release" (no quotes). The system will reply with a confirmation via E-mail of each subscription. A second automatic message will include additional information on the service. Questions should be directed to (202) 358-4043.*

# NASA News

National Aeronautics and  
Space Administration

Washington, D.C. 20546  
202 358-1600



For Release

Douglas Isbell  
Headquarters, Washington, D.C.  
(Phone: 202/358-1753)

September 21, 1994

RELEASE: 94-159

## **NASA NAMES SCIENCE TEAM FOR ASTEROID RENDEZVOUS MISSION**

NASA has selected the science team for the first spacecraft designed to rendezvous with an asteroid.

The Near Earth Asteroid Rendezvous (NEAR) mission promises to answer fundamental questions about the nature of near-Earth objects such as asteroids and comets. These objects are believed to consist of debris from the earliest days of planetary formation 4.5 billion years ago, so better knowledge of them should provide clues about the origin and evolution of the Solar System.

Scheduled for launch in February 1996 aboard a Delta 2 rocket, the NEAR spacecraft should arrive in orbit around asteroid 433 Eros in early January 1999. It will then survey the rocky body for a minimum of one year, at altitudes as close as 15 miles (24 kilometers). Eros is one of the largest and best-observed asteroids whose orbits cross Earth's path. These asteroids are closely related to the more numerous "Main Belt" asteroids that orbit the Sun in a vast doughnut-shaped ring between Mars and Jupiter.

The goal of the NEAR project is to carry out a mission with high scientific return and wide participation at relatively modest cost. It will seek the first comprehensive measurements of an asteroid's mass, structure, geology, mineral composition, and gravity and magnetic fields. Science data and related products will be archived in near real-time in NASA's Planetary Data System (PDS), with access for the general science community, the public and educators via the Internet.

The NEAR Science Payload consists of six instruments: a multispectral imager system; a near-infrared spectrograph; an X-ray/gamma-ray spectrometer; a magnetometer; a laser altimeter; and the spacecraft's radio, which is also used for gravity measurements.

-more-

The members of the NEAR science team are:

**Multispectral Imager/Near-Infrared Spectrograph**

Joseph Veverka, Cornell University (Team Leader), Ithaca, N.Y.  
James F. Bell III, NASA Ames Research Center, Mountain View, Calif.  
Clark R. Chapman, Planetary Science Institute, Tucson, Ariz.  
Michael C. Malin, Malin Space Science Systems, Inc., San Diego, Calif.  
Lucy-Ann A. McFadden, University of Maryland, College Park, Md.  
Mark S. Robinson, U.S. Geological Survey, Flagstaff, Ariz.  
Peter C. Thomas, Cornell University

**X-ray/Gamma-Ray Spectrometer**

Jacob I. Trombka, NASA Goddard Space Flight Center (Team Leader), Greenbelt, Md.  
William V. Boynton, University of Arizona, Tucson  
Johannes Bruckner, Max Planck Institut fur Chemie, Mainz, Germany  
Steven W. Squyres, Cornell University

**Magnetometer**

Mario H. Acuna, Goddard Space Flight Center (Team Leader)  
Christopher T. Russell, University of California, Los Angeles

**Light Imaging Detector and Ranger (LIDAR)**

Maria T. Zuber, Goddard Space Flight Center (Team Leader)

**Radio Science**

Donald K. Yeomans, NASA Jet Propulsion Laboratory (Team Leader), Pasadena, Calif.  
Jean-Pierre Barriot, Centre National D'Etudes Spatiales, Toulouse, France  
Alexander S. Konopoliv, Jet Propulsion Laboratory

The NEAR Project Science Group will be co-chaired by Dr. Jurgen Rahe, the NASA Headquarters Program Scientist, and Dr. Andrew F. Cheng, NEAR Project Scientist at the Johns Hopkins University Applied Physics Laboratory (APL) in Laurel, Md. APL will build and operate NEAR, making it the first NASA planetary mission to be conducted by a non-NASA space center.

The facility-class Instrument Scientists at APL will be the main interface between the science team leaders and project engineers. The Instrument Scientists are:

- Scott L. Murchie (Multispectral Imager/Near-Infrared Spectrograph)
- Ralph L. McNutt (X-ray/Gamma-Ray Spectrometer)
- Larry J. Zanetti (Magnetometer)
- Andrew F. Cheng (LIDAR)

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The NEAR project began in late 1993. NEAR will be the first launch in NASA's Discovery program, an initiative based on small planetary science missions with short development cycles and stringent cost caps. It requires missions to proceed from development to flight in less than three years, with total spacecraft and instrument development costs limited to no more than \$150 million (in FY 1992 dollars) and an acceptance of a greater level of technical risk than on typical NASA missions.

The Solar System Exploration Division of the Office of Space Science at NASA Headquarters has program management responsibility for the NEAR mission.

-end-

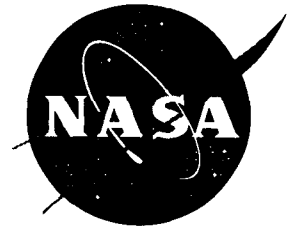
**EDITOR'S NOTE:** A color print of an artist's conception of the NEAR spacecraft is available to news media by faxing your request to the NASA Headquarters Broadcast and Imaging Branch on 202/358-4333. The photo number for a black and white print is 93-H-474 and for color is 93-HC-426.

*NASA press releases and other information are available automatically by sending an Internet electronic mail message to [domo@hq.nasa.gov](mailto:domo@hq.nasa.gov). In the body of the message (not the subject line) users should type the words "subscribe press-release" (no quotes). The system will reply with a confirmation via E-mail of each subscription. A second automatic message will include additional information on the service. Questions should be directed to (202) 358-4043.*

# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
202 358-1600



Sarah Keegan  
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For Release  
September 21, 1994

Jim Elliott  
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(Phone: 301/286-6256)

Ray Villard  
Space Telescope Science Institute, Baltimore, Md.  
(Phone: 410/338-4514)

RELEASE: 94-160

## **HUBBLE UNCOVERS A HIDDEN QUASAR IN A NEARBY GALAXY**

Astronomers using NASA's Hubble Space Telescope have found a new quasar -- not billions of light years away like its known cousins, but a mere 600 million light years, the equivalent of Earth's cosmic backyard.

"I was stunned when we realized we had a quasar; it was a total surprise," said Dr. Anne Kinney of the Space Telescope Science Institute, Baltimore, Md. Until this discovery all known quasars existed in the early universe. "So it is unusual to find one in our own epoch," Dr. Kinney said.

The discovery in galaxy Cygnus A will give astronomers their first opportunity for detailed study of a quasar, an object which looks like a pinpoint of light (as does a star) to a ground-based telescope. A quasar, though, emits hundreds of times more energy than an entire galaxy with more than 100 billion stars.

There is evidence that the quasars -- short for "quasi-stellar radio sources" -- found in the remote galaxies are powered by supermassive black holes that devour dust, gas and stars from the host galaxies, producing enormous amounts of energy in the process. Beyond that, little is known about them, which makes this discovery so important.

Dr. Kinney emphasized that this unexpected result implies that all radio galaxies might harbor quasars that are hidden from view.

The observations were made by Robert Antonucci and Todd Hurt of the University of California at Santa Barbara, and Kinney. Their results appear in the September 22 issue of Nature.

- more -

Though Cygnus A is categorized as an elliptical galaxy, it has an unusual peanut shape due to a dark band of dust encircling the enigmatic nucleus. The Hubble astronomers could only peek into the core by taking advantage of a natural "periscope effect." Dust outside of the nucleus acts like a mirror to reflect the shorter wavelengths, or blue component, of the light toward Earth.

The astronomers used the ultraviolet sensitivity of the Faint Object Spectrograph to look for the spectral signature of extremely hot, supermassive stars hidden in the nucleus. Such stars are theorized as one possible explanation for Cygnus A's powerful optical emissions.

Instead, the resulting ultraviolet spectrum was so unusual that astronomers puzzled over the data for three months before reaching their startling conclusion. After much analysis, they realized it was in part composed of the typical spectrum of a quasar. Such a spectrum possesses broad emission lines that indicate that gas in the nucleus is swirling at high speeds. "One caveat is that the broad emission line could possibly be many narrow emission lines blended together," Kinney said. "We will double check that possibility with more observations." HST's ultraviolet sensitivity allowed this spectrum to be distinguished more easily from the galaxy's starlight.

Kinney emphasized that it is probably more than coincidence to find a quasar embedded in the nearest extremely powerful radio galaxy to Earth. These results suggest that quasars might be common to radio galaxies and might explain their powerful radio emissions, she added.

Though this provides an unexpected opportunity for close-up study of the mysterious "engine" behind a quasar, these results add further mystery as to the true nature of the powerhouse.

Previous ground-based radio observations show that there is an elongated object in Cygnus A's core. This is inconsistent with black hole models that predict a compact point source of radiation. Supermassive black holes are a leading candidate for explaining a quasar's prodigious outpouring of energy.

The astronomers plan to use the Hubble Space Telescope to study the spectrum of other radio galaxies and look for fingerprints of other quasars.

The Hubble Space Telescope is a project of international cooperation between NASA and the European Space Agency (ESA).

- end -

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# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
202 358-1600



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For Release  
September 26, 1994

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Ray Villard  
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NOTE TO EDITORS: N94-67

## **"COMET S-L 9: AFTER THE CRASH" SPACE ASTRONOMY UPDATE SEPT. 29**

The aftermath of this summer's spectacular crash of Comet Shoemaker-Levy 9 with Jupiter will be the topic of the next Space Astronomy Update news briefing at 1 p.m. EDT, September 29 in the NASA Headquarters Auditorium, 300 E. St., S.W., Washington, D.C.

"Comet Shoemaker-Levy 9: After The Crash" will include recent observations and science performed after the impacts on Jupiter. The panelists, members of the Hubble Space Telescope science team studying the comet's collision with Jupiter, will present new images showing the evolving impact sites and update some of the surprising discoveries made since the comet slammed into Jupiter the week of July 16-22.

The panelists will be Dr. John T. Clarke, Dr. Melissa McGrath, Dr. Heidi B. Hammel and Dr. Harol Weaver. The moderator will be Dr. Steve P. Maran of NASA's Goddard Space Flight Center, Greenbelt, Md.

NASA TV is carried on Spacenet 2, transponder 5, channel 9, 69 degrees West. The transponder frequency is 3880 MHz, the audio is 6.8 MHz, and polarization is horizontal. The briefing will be broadcast live with two-way question-and-answer capability for reporters covering the briefings from participating NASA centers.

- end -

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# NASA News

National Aeronautics and  
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Washington, D.C. 20546  
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For Release  
September 29, 1994

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RELEASE: 94-161

## **HUBBLE OBSERVATIONS SHED NEW LIGHT ON JUPITER COLLISION**

Was it a comet or an asteroid?

Scientists are debating that question as they continue to pore over Hubble Space Telescope imaging and spectroscopic data gleaned in the wake of the spectacular July bombardment of Jupiter by comet P/Shoemaker-Levy 9.

Their initial findings, combined with results from other space-borne and ground-based telescopes, shed new light on Jupiter's atmospheric winds, its immense magnetic field, the mysterious dark debris from the impacts, and the composition of the doomed comet itself.

These early results are being presented at a press conference today at NASA Headquarters, Washington D.C., by astronomers John Clarke, University of Michigan, Ann Arbor; Heidi Hammel, Massachusetts Institute of Technology, Cambridge; and Harold Weaver and Melissa McGrath, Space Telescope Science Institute, Baltimore.

## **THE LAST DAYS OF THE COMET**

Before the comet impact, there was a great deal of speculation and prediction about whether the 21 nuclei would survive before reaching Jupiter, or were so fragile that gravitational forces would pull them apart into thousands of smaller fragments. Hubble helped solve this question by watching the nuclei until about 10 hours before impact. HST's high resolution images show that the nuclei, the largest of which were probably a few kilometers across, did not break up catastrophically before plunging into Jupiter's atmosphere. This reinforces the notion that the atmospheric explosions were produced by solid, massive impacting bodies.

- more -

HST's resolution also showed that the nuclei were releasing dust all along the path toward Jupiter, as would be expected from a comet. This was evident in the persistence of spherical clouds of dust surrounding each nucleus throughout most of the comet's journey. About a week before impact, these dust clouds were stretched out along the path of the comet's motion by Jupiter's increasingly strong gravity.

### **WAS P/SHOEMAKER-LEVY 9 A COMET OR AN ASTEROID?**

At present, observations seem to slightly favor a cometary origin, though an asteroidal origin cannot yet be ruled out. The answer isn't easy because comets and asteroids have so much in common: they are small bodies; they are primordial, having formed 4.6 billion years ago along with the planets and their satellites; either type of object can be expected to be found in Jupiter's vicinity. The key difference is that comets are largely icy while the asteroids are virtually devoid of ice because they formed too close to the Sun. The attached table summarizes the observational results that shed light on this question.

### **WHAT IS THAT DARK STUFF MADE OF?**

The HST Faint Object Spectrograph (FOS) detected many gaseous absorptions associated with the impact sites and followed their evolution over the next month. Most surprising were the strong signatures from sulfur-bearing compounds like diatomic sulfur (S<sub>2</sub>), carbon disulfide (CS<sub>2</sub>), and hydrogen sulfide (H<sub>2</sub>S). Ammonia (NH<sub>3</sub>) absorption also was detected. The S<sub>2</sub> absorptions seemed to fade on timescales of a few days, while the NH<sub>3</sub> absorptions at first got stronger with time, and finally started fading after about one month. During observations near the limb of Jupiter, the FOS detected emissions from silicon, magnesium and iron that could only have originated from the impacting bodies, since Jupiter itself normally does not have detectable amounts of these elements.

### **SWEPT ACROSS JUPITER**

Observations made with HST's Wide Field Planetary Camera-2, a week and a month after impact, have been used to make global maps of Jupiter for tracking changes in the dark debris caught up in the high-speed winds at Jupiter's cloudtops. This debris is a natural tracer of wind patterns and allows astronomers a better understanding of the physics of the Jovian atmosphere. The high speed easterly and westerly jets have turned the dark "blobs" originally at the impact sites into striking "curly-cue" features. Although individual impact sites were still visible a month later despite the shearing, the fading of Jupiter's scars has been substantial and it now appears that Jupiter will not suffer any permanent changes from the explosions.

Hubble's ultraviolet observations show the motion of very fine impact debris particles now suspended high in Jupiter's atmosphere. The debris eventually will diffuse down to lower altitudes. This provides the first information ever obtained about Jupiter's high altitude wind patterns. Hubble gives astronomers a "three dimensional" perspective showing the wind patterns at high altitudes and how they differ from those at the visible cloudtop level. At lower altitudes, the impact debris follows east-west winds driven by sunlight and Jupiter's own internal heat. By contrast, winds in the high Jovian stratosphere move primarily from the poles toward the equator because they are driven mainly by auroral heating from high energy particles.

### **PIERCING JUPITER'S MAGNETIC FIELD**

About four days before impact, at a distance of 2.3 million miles from Jupiter, nucleus "G" of comet P/Shoemaker-Levy 9 apparently penetrated Jupiter's powerful magnetic field, the magnetosphere. (Jupiter's magnetosphere is so vast, if visible from Earth, it would be about the size of the full Moon.)

Hubble's Faint Object Spectrograph (FOS) recorded dramatic changes at the magnetosphere crossing that provided a rare opportunity to gather more clues on the comet's true composition. During a two minute period on July 14, HST detected strong emissions from ionized magnesium (Mg II), an important component of both comet dust and asteroids. However, if the nuclei were ice-laden -- as expected of a comet nucleus -- astronomers expected to detect the hydroxyl radical (OH). Hubble did not see OH, casting some doubt on the cometary nature of comet P/Shoemaker-Levy 9. Eighteen minutes after comet P/Shoemaker-Levy 9 displayed the flare-up in Mg II emissions, there was also a dramatic change in the light reflected from the dust particles in the comet.

### **NEW AURORAL ACTIVITY**

HST detected unusual auroral activity in Jupiter's northern hemisphere just after the impact of the comet's "K" fragment. This impact completely disrupted the radiation belts which have been stable over the last 20 years of radio observations.

Aurorae, glowing gases that create the northern and southern lights, are common on Jupiter because energetic charged particles needed to excite the gases are always trapped in Jupiter's magnetosphere. However, this new feature seen by Hubble was unusual because it was temporarily as bright or brighter than the normal aurora, short-lived, and outside the area where Jovian aurorae are normally found. Astronomers believe the K impact created an electromagnetic disturbance that traveled along magnetic field lines into the radiation belts. This scattered charged particles, which normally exist in the radiation belts, into Jupiter's upper atmosphere.

X-ray images taken with the ROSAT satellite further bolster the link to the K impact. They reveal unexpectedly bright X-ray emissions that were brightest near the time of the K impact, and then faded.

The Space Telescope Science Institute is operated by the Association of Universities for Research in Astronomy, Inc. (AURA) for NASA, under contract with the Goddard Space Flight Center, Greenbelt, Md. The Hubble Space Telescope is a project of international cooperation between NASA and the European Space Agency (ESA).

- end -

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For Release

Brian Dunbar  
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September 28, 1994

Mary Hardin  
Jet Propulsion Laboratory, Pasadena, Calif.  
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RELEASE: 94-162

## **TOPEX/POSEIDON CHARTS LONG TERM EL NINO INFLUENCE ON CLIMATE**

More than a decade after affecting climate on a global scale, residual signs of a powerful El Nino are still visible from space.

Oceanographers using data from the U.S.-French TOPEX/POSEIDON satellite are tracking the remnant wave of the 1982-83 El Nino event as it moves across the Northwest Pacific Ocean, where some scientists theorize it may still be affecting weather in the region.

El Nino is a climatic phenomenon that can bring devastating weather to several global regions, including heavy rains and flooding to California, colder than normal winters across the United States and severe droughts and dust storms to Australia.

"The fact that we are seeing this wave 10 years later is an amazing discovery in and of itself," said Dr. Gregg Jacobs of the Naval Research Laboratory (NRL) facility located at the Stennis Space Center, Mississippi. "The ability to observe changes in global ocean circulation as we have seen over the Kuroshio region is a demonstration that the TOPEX/POSEIDON satellite is the most valuable global ocean observing tool we have. We wouldn't have been able to do this work without TOPEX/POSEIDON," Jacobs continued.

An El Nino begins when warm water builds up in the equatorial Pacific and moves eastward toward the coast of the Americas. When this movement, called a Kelvin wave, reaches the coastline, it is "reflected" and moves back across the Pacific in the form of a Rossby wave that continues to affect climate and ocean circulation. The 1982-83 El Nino was the worst such event this century, and its effects were felt around the world.

-more-

NRL oceanographers noticed the Rossby wave produced by the 1982-83 El Nino while they were studying TOPEX/POSEIDON ocean-circulation data of the Kuroshio current off the coast of Japan.

"The TOPEX/POSEIDON data showed the Kuroshio current farther north than it has been observed in earlier data sets," said Jacobs. "While we were investigating this intriguing change, we discovered the Rossby wave was actually pushing the current northward, raising the temperature of the northwest Pacific."

TOPEX/POSEIDON, a joint program of NASA and the Centre Nationale d'Etudes Spatiales, the French space agency, uses a radar altimeter to precisely measure sea-surface height. Scientists use the TOPEX/POSEIDON data to produce global maps of ocean circulation, which can be used to identify Kelvin and Rossby waves.

TOPEX/POSEIDON is part of NASA's Mission to Planet Earth, a coordinated, long-term research program to study the Earth as a single global environment. TOPEX/POSEIDON's sea-surface height data are essential to understanding the role oceans play in regulating global climate, one of the least understood areas of climate research.

The TOPEX/POSEIDON data will enable oceanographers to monitor the movement of other Rossby waves initiated by El Nino events during the past decade. The El Ninos of 1986-87 and 1991-93 have produced Rossby waves that are now propagating across the Pacific Ocean. With continued observations from TOPEX/POSEIDON, oceanographers will be able to study the development and impact of these waves.

"As we now know, these waves are capable of producing dramatic changes in climate, and TOPEX/POSEIDON provides the key to watching for these changes and allowing us to prepare for them," Jacobs said.

While oceanographers still can't predict exactly when an El Nino event will occur, the TOPEX/POSEIDON data do give them several months warning before the onset of a new event.

"And unlike El Nino events, Rossby waves are much more predictable," according to Jacobs. "Given the year of an El Nino, we know exactly when the Rossby wave's effects will be felt on the opposite side of the Pacific Ocean."

"As the world's population grows, humanity becomes more dependent upon reliable resources. Interruptions such as El Nino are made more devastating by their sudden, unforeseen appearance. The monitoring and understanding of the world's oceans provided by TOPEX/POSEIDON helps mitigate the possible disastrous consequences of what is Earth's nature cycle."

JPL manages the NASA portion of TOPEX/POSEIDON. Launched Aug. 10, 1992, the satellite has completed two years of its three-year prime mission and has provided oceanographers with unprecedented global sea level measurements that are accurate to less than 5 centimeters (2 inches).

- end -

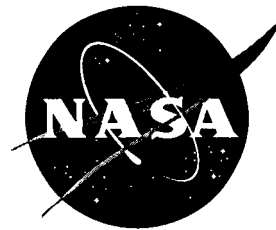
NOTE TO EDITORS: A black-and-white line graphic illustrating the development of the El Nino current is available on-line via the World Wide Web system from JPL's home page at the address, <http://www.jpl.nasa.gov/> under the "News flash" heading, or by anonymous file transfer protocol (ftp) from [jplinfo.jpl.nasa.gov](ftp://jplinfo.jpl.nasa.gov) in the "News" directory as filename `tpxnino.gif`.

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202 358-1600



David E. Steitz  
Headquarters, Washington, D.C.  
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For Release  
September 30, 1994

RELEASE: 94-163

## **NASA MINORITY CONTRACTORS OF THE YEAR AWARDED**

Two companies have been recognized as minority contractor and subcontractor of the year for their outstanding contributions to the space program.

NASA Administrator Daniel S. Goldin has named ERC, Inc., Tullahoma, TN, as Minority Contractor of the Year. BST Systems, Inc., Plainfield, CT, has been named Minority Subcontractor of the Year.

ERC, Inc., nominated by the Marshall Space Flight Center, Huntsville, AL, was recognized for providing outstanding critical technical support in a variety of propulsion applications including internal flow tests and computational fluid dynamics analysis, neural network data screening, and systems engineering. ERC also performed training and executive information systems services, communication support and technology utilization. Dr. Y.C.L. Susan Wu, President of ERC, Inc., is a prominent scientist in aeronautics and astronautics. Wu is the 1994 recipient of the AIAA Plasmadynamics and Lasers Award, and was recently appointed by President Clinton to the National Air and Space Museum Advisory Board.

BST Systems, Inc., nominated by USBI Facilities Group, United Technologies Inc., performing under contract to Marshall, was chosen as Minority Subcontractor of the Year. BST Systems has provided critical technical support by designing, developing and manufacturing range safety system and operational flight instrumentation batteries for the Space Shuttle's solid rocket boosters. BST Systems, Inc., is headed by Maximino Solis, Chairman of the Board and CEO, and Thomas Terjesen, president and Chief Operating Officer.

Goldin also cited three NASA employees for their significant achievements in fostering contracting with Small Disadvantaged Businesses at their respective centers. They are James E. Towles, Kennedy Space Center, FL.; A. Vernon Vann, Langley Research Center, Hampton, VA; and Thomas A. Spicer, Lewis Research Center, Cleveland, OH.

The awards will be presented in a ceremony beginning at 2:30p.m. on Thursday, Oct. 13, in the NASA Headquarters Auditorium, 300 E Street, S.W., Washington, D.C. The ceremony will be open to the public with a reception following.

-end-

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National Aeronautics and  
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For Release

Mark Hess  
Headquarters, Washington, D.C.  
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September 30, 1994

Kari Fluegel  
Johnson Space Center, Houston  
(Phone: 713/483-5111)

RELEASE: 94-164

## **SPACE STATION MANAGERS RELEASE UPDATED ASSEMBLY PLAN**

Assembly sequence refinements that incorporate the latest updates to plans for the International Space Station were announced by program officials today.

The sequence enhances the Space Station's science utilization by incorporating early provisions for a centrifuge. It also allows for the construction of Russia's Solar Power Platform earlier and meshes the latest weight estimates for Station components with current Space Shuttle Program launch commitments.

"These changes do not affect our major milestones, but do improve upon the previous assembly sequence and hold the line on program costs," said Program Manager Randy Brinkley. "This program is making great progress toward the start of assembly in November 1997."

The Space Station Control Board -- which includes representation from NASA, all of the international partners and the Boeing Station team -- met this week at the Johnson Space Center in Houston to review adjustments and refinements to the program.

"These meetings are our opportunity to review the progress of the program with our international and contractor partners," said Program Director Wilbur Trafton. "I am pleased with the stability of the program and with the progress we're making."

The assembly sequence now reflects the Russian Space Agency's plan to construct the solar power platform during the late-1998 to mid-1999 timeframe -- about 16 months earlier than previously planned. The change provides the Russian portion of the Station with power and eliminates the need to transfer U.S. power to the Russian modules.

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The sequence also provides for the early incorporation of a proposed centrifuge module that would augment the Station's science capabilities. Though detailed plans regarding the module's feasibility and design are still being worked, Brinkley said program managers decided to include a "placeholder" flight for the module in the assembly sequence.

"As we go through the design process, we will continue to identify areas where our early assessments need adjustment," Brinkley said. "These minor refinements may change the payload manifests of individual flights, but the major milestones will remain steady. That is the nature of an aggressive, dynamic design program."

The largest international scientific and technological development ever undertaken, the International Space Station will bring together resources from the United States, Russia, member nations of the European Space Agency, Canada and Japan. Assembly will begin in November 1997, followed by the launch of the U.S. Lab Module in November 1998, the Canadian Robot Arm in December 1998, the Japanese Experiment Module in March 2000 and the European Experiment Module in February 2001. Assembly is scheduled to be complete in June 2002.

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